IMPLEMENTATION OF THE FEDERAL TECHNOLOGY TRANSFER ACT

HEARING

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

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SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

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IMPLEMENTATION OF THE FEDERAL TECHNOLOGY TRANSFER ACT

THURSDAY, JUNE 1, 1989

House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Science, Research and Technology,
Washington, D.C.

The subcommittee met, pursuant to call, at 9:32 a.m., in Room 2318, Rayburn House Office Building, Hon. Doug Walgren, [chairman of the subcommittee] presiding.

Mr. Walgren. Let me call us to order and welcome you to our hearing today on technology transfer, and, without objection, any recordings, television or radio or sound, will be permitted in this hearing and, since I'm the only one here, there will be no objection. [Laughter.]

Technological innovation is the force that drives economic growth and industrial productivity in today's world and here in the United States. Although we still set the pace in basic science, we all know that our competitors have become truly adept at transforming the results of that basic science, much of which is developed in the United States, into new products and services which then attract the consumers' attention and their dollars.

This Committee has long taken an active role in encouraging American industry to increase its commitment to the difficult task of transforming an idea into a better product, and while we know that only private industry can do this job, we also realize that there are many things the Federal Government can do to make the private sector's role in that job more effective.

One of the—one of these is to increase the availability of the products of Federal research, a process commonly thought of as technology transfer. One-sixth of the scientists and engineers in this country work for the Federal Government in laboratories and in other capacities and they do a great deal of research that has tremendous potential for commercial application.

For 10 years now, we have been promoting legislation to try to encourage the circumstances under which the best commercial ideas from what is over $60 billion per year in Federal efforts of research and development, to try to encourage the circumstances under which the fruits of that effect would transfer and be developed in the commercial marketplace.

The Federal Technology Transfer Act of 1986 is the most recent statutory effort to promote that technology transfer. That Act calls for very real changes in the way ideas originating in Federal laboratories are evaluated for commercial potential and are encouraged and made available to U.S. companies in the private sector.

In the two and a half years since the Act became law, the implementation of it has been a mixed story. The Federal Laboratory Consortium for Technology Transfer, which was given a formal charter and stable funding by that Act, has been visibly strengthened, and its membership has increased, and its services have been more broad-spread for its member laboratories.

And since the Act provided the incentive of royalty-sharing to Federal inventors who work for commercialization of their inventions, licensing of federally developed inventions appears to be on the rise.

Some laboratories routinely enter into Cooperative Research and Development Agreements with industry, as was envisioned under the Act, and yet, others have yet to receive specific authority from their headquarters and the levels of bureaucracy to which they report, even though the Act, as reinforced by the Executive Order implementing these directions, mandates that all laboratories be delegated such authority.

There are several labs who have in system—have in place—systems to evaluate inventors' performance in technology transfer, but many have yet to establish the kind of evaluation system that is envisioned by that Act.

Today, we'll have a representative of the General Accounting Office as the lead-off witness to give an assessment of the current state of technology transfer from the Federal laboratories and to assure more uniform implementation of the Act, this Committee asked the General Accounting Office to review the extent of laboratory and agency compliance with the Act.

GAO was also asked to develop a series of questionnaires to enable us to understand how well that Act is working and why it is successful, where it is working.

After the General Accounting Office, we will hear from several of the Federal laboratories to learn if their efforts have been successful within their own view and how they—those experiences might be applied to other laboratories that have not gone as far.

Finally, we will hear from representatives of the Department of Defense to find out what can be done to increase the transfer of technology to American industry from the Defense Department, in view of the fact that the Defense Department funds almost one-third of the research and development that is conducted in the Country.

We'll hold the record open at this point for opening statements which may be offered by other Members who are unable to be with us at the outset and we'll introduce for the record at this point an opening statement by Congressman Jerry Costello on the subject of these hearings.

[The prepared opening statements of Hon. Doug Walgren, and Hon. Jerry Costello follow:]

Opening Statement
U.S. Representative Doug Walgren

Hearing on Technology Transfer

June 1, 1989

TECHNOLOGICAL INNOVATION IS THE FORCE THAT DRIVES ECONOMIC GROWTH AND INDUSTRIAL PRODUCTIVITY IN THE MODERN WORLD. HERE IN THE UNITED STATES, WE STILL SET THE PACE IN BASIC SCIENCE, BUT AS WE ALL KNOW, OTHER COUNTRIES HAVE BECOME MORE ADEPT AT TRANSFORMING THE RESULTS OF THAT SCIENCE INTO THE NEW AND IMPROVED PRODUCTS AND SERVICES WHICH ENHANCE OUR QUALITY OF LIFE.

THIS COMMITTEE HAS LONG TAKEN AN ACTIVE ROLE IN ENCOURAGING AMERICAN INDUSTRY TO INCREASE ITS COMMITMENT TO THE EXPENSIVE AND VERY RISKY PROCESS OF TRANSFORMING A BETTER IDEA INTO A BETTER PRODUCT. WHILE WE KNOW THAT ONLY PRIVATE INDUSTRY CAN DO THIS JOB, WE ALSO REALIZE THERE ARE MANY THINGS THE FEDERAL GOVERNMENT CAN DO TO MAKE THE PRIVATE SECTOR'S JOB EASIER. ONE OF THESE IS TO INCREASE THE AVAILABILITY OF THE FRUITS OF FEDERAL RESEARCH, A PROCESS COMMONLY CALLED TECHNOLOGY TRANSFER. ONE SIXTH OF THE SCIENTISTS AND ENGINEERS IN THIS COUNTRY WORK FOR THE FEDERAL

LABORATORIES AND THEY DO A GREAT DEAL OF RESEARCH WITH POTENTIAL COMMERCIAL APPLICATION.

FOR A DECADE NOW WE HAVE BEEN PROMOTING LEGISLATION TO MAKE SURE THE BEST COMMERCIAL IDEAS FROM THE OVER $60 BILLION PER YEAR IN FEDERAL RESEARCH AND DEVELOPMENT EXPENDITURES ENTER THE COMMERCIAL MARKETPLACE AS PRODUCTS WHICH ARE MADE IN AMERICA. THE FEDERAL TECHNOLOGY TRANSFER ACT OF 1986 IS OUR MOST RECENT STATUTORY EFFORT TO PROMOTE TECHNOLOGY TRANSFER. THIS ACT CALLS FOR FAR-REACHING CHANGES IN THE WAY IDEAS ORIGINATING IN FEDERAL LABS ARE EVALUATED FOR COMMERCIAL POTENTIAL, ARE NURTURED, AND ARE MADE AVAILABLE TO U.S. COMPANIES.

IN THE TWO AND ONE-HALF YEARS SINCE THE ACT BECAME LAW, IMPLEMENTATION HAS BEEN MIXED. THE FEDERAL LABORATORY CONSORTIUM FOR TECHNOLOGY TRANSFER, WHICH WAS GIVEN A FORMAL CHARTER AND STABLE FUNDING BY THAT ACT, HAS BEEN VISIBLY STRENGTHENED. IT NOW HAS A BROADER MEMBERSHIP AND PERFORMS ADDITIONAL SERVICES FOR ITS MEMBER LABORATORIES. AND, SINCE THE ACT PROVIDED THE INCENTIVE OF ROYALTY SHARING TO FEDERAL INVENTORS

WHO WORK FOR COMMERCIALIZATION OF THEIR INVENTIONS, LICENSING OF FEDERALLY OWNED INVENTIONS APPEARS TO BE ON THE RISE.

WHILE SOME LABORATORIES ROUTINELY ENTER INTO COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS WITH INDUSTRY, OTHERS HAVE YET TO RECEIVE AUTHORITY TO DO SO FROM HEADQUARTERS--EVEN THOUGH THE ACT, AS INTERPRETED BY AN EXECUTIVE ORDER, MANDATES SUCH DELEGATION. A FEW LABS HAVE SYSTEMS IN PLACE TO EVALUATE INVENTORS' PERFORMANCE IN TECHNOLOGY TRANSFER, BUT MANY HAVE YET TO ESTABLISH THE COMPREHENSIVE SYSTEM ENVISIONED BY THE ACT.

A REPRESENTATIVE OF THE GENERAL ACCOUNTING OFFICE, AS OUR LEAD OFF WITNESS, WILL GIVE GAO'S ASSESSMENT OF THE CURRENT STATE OF TECHNOLOGY TRANSFER FROM THE FEDERAL LABS. TO ASSURE MORE UNIFORM IMPLEMENTATION OF THE ACT, THE COMMITTEE COMMISSIONED THE GAO TO REVIEW THE EXTENT OF LABORATORY AND AGENCY COMPLIANCE WITH THE ACT. GAO WAS ALSO ASKED TO DEVELOP A SERIES OF QUESTIONNAIRES TO PERMIT US TO UNDERSTAND HOW WELL THE ACT IS WORKING AND WHY.

NEXT WE WILL HEAR FROM SOME INNOVATIVE FEDERAL LABORATORIES TO LEARN IF THEIR EFFORTS CAN BE APPLIED TO OTHER LABORATORIES. AND FINALLY, WE WILL HEAR FROM REPRESENTATIVES FROM THE DEPARTMENT OF DEFENSE TO FIND OUT WHAT CAN BE DONE TO INCREASE THE TRANSFER OF TECHNOLOGY TO AMERICAN INDUSTRY SINCE THAT DEPARTMENT FUNDS ABOUT ONE-THIRD OF THE RESEARCH AND DEVELOPMENT CONDUCTED IN THIS COUNTRY.

OPENING STATEMENT
BY U.S. REP. JERRY COSTELLO
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
JUNE 1, 1989
"IMPLEMENTATION OF THE FEDERAL TECHNOLOGY TRANSFER ACT"

Mr. Chairman, we have seen in recent years many of our trading partners make effective commercial use out of research and technology advances discovered in laboratories funded by the federal government.

The United States has not been as effective in developing these spinoff discoveries for our country's commercial or economic gain. The 1986 Federal Technology Transfer Act will allow federally operated laboratories to enter into cooperative research and development agreements with private parties.

I look forward to hearing how the Act has been received and the actual effect it has had on technology transfer and the economic gain it has given to American businesses. In addition, given that a large amount of federal research is done through the Department of Defense, I am interested to hear why DOD has been slow in implementing this Act.

Mr. WALGREN. Well, with that, let me introduce to the record the first panel. John Ols, Director of Resources, Community and Economic Development Division of the GAO; accompanied by a number of support people who've worked on this problem with him. We appreciate your coming to be with us this morning and we want to express our appreciation for the time and—and attention that you have given this area in response to our committee's interest.

As you know, written statements for all the witnesses will be made part of the record without more and you can feel free to focus on parts of those statements or particularly underscore points that you would like to have stand out in the verbal part of the transcript for those who work with that document.

Welcome to the Committee, Mr. Ols. We appreciate your being here.

STATEMENT OF JOHN M. OLS, DIRECTOR OF RESOURCES, COMMUNITY AND ECONOMIC DEVELOPMENT DIVISION, GENERAL ACCOUNTING OFFICE; ACCOMPANIED BY LOWELL MININGER, ASSISTANT DIRECTOR; SUMI ARIMA, EVALUATOR-IN-CHARGE; AND CYNTHIA WALFORD, PROJECT MANAGER

Mr. OLS. All right, thank you, Mr. Chairman.

I'd like to introduce the colleagues that are with me today. To my immediate right is Lowell Mininger, who is the Assistant Director on this particular project and does a lot of our work in the technology transfer area; to his immediate right is Sumi Arima, who is the Evaluator in charge on this identical—this specific one we're working on; and to my immediate left is Cynthia Walford, who is the Project Manager on the questionnaire job that you referred to that we're moving forward on.

With that, I'd just like to summarize the detailed report that we've released today, which is available, which was requested by the Chairman and Ranking Minority Member of the Committee on Science, Space, and Technology.

As requested, that report provides information on the progress the 12 Federal agencies in 25 of their laboratories have made in implementing the Act.

Federal agencies have taken numerous actions to implement the Federal Technology Transfer Act of 1986. Ten of the agencies we contacted had delegated authority to their laboratories to enter into cooperative research and development activities. As of February, 1989, the agencies contacted had entered into a total of 172 agreements under the specific authority of the '86 Act. In addition, some agencies continue to enter into agreements under their respective authorizing acts.

As required by the Act, each of the Federal agencies either had distributed or planned to distribute to Federal inventors at least 15 percent of the royalties collected and one agency had established a new cash awards program focused solely on technology transfer. The Department of Commerce has drafted its first biennial report on the extent to which Federal agencies have implemented the 1986 Act and that report is in final process as of today.

The agencies have submitted all other reports required by the Act to date. We believe that it is too early to determine the total impact the Act has had on technology transfers. Further, although agencies reported undertaking numerous technology transfer activities, the reported activities are defined differently and, consequently, uniform statistical information has not been made—has not been available to make a comprehensive evaluation.

To resolve this problem and facilitate evaluating the impact of the Act on technology transfer, as you had indicated in your opening statement, we are conducting a separate review to develop criteria for reporting technology transfer activities.

Before discussing some of the details of the work we had performed, I'd like to present some background on the Act.

As you know, the Federal Technology Transfer Act amended the Stevenson-Wydler Technology Innovation Act of 1980 to permit Federal agencies to delegate authority to government-operated laboratories to enter into cooperative research and development agreements with entities in both public and private sector. Under such an agreement, one or more Federal agencies, through their laboratories, corroborate with one or more non-Federal parties in conducting specified research and development efforts that are consistent with the laboratories' missions.

The Act sought to make entering into such agreements as easy as possible while protecting legitimate concerns of the government. To provide incentives for Federal employees to promote technology transfer, the Act also established royalty-sharing for Federal inventions and directed agencies to provide cash awards focused on technology transfer.

In addition, the Act contains a number of reporting requirements, including the one I mentioned already by the Secretary of Commerce.

I'd like to summarize the details of our work and only concentrate on a few of the aspects that we—that we covered in the report that is being released today, and it's only because we decided to bring these forward in highlighting those particular activities.

I'll start with the delegation of authority to enter into cooperative agreements. Ten of the 12 agencies we contacted had delegated authority to their laboratories to enter into such agreements. In making the delegations, however, some agencies define laboratories to be headquarters offices at higher organizational levels than field laboratories or research centers. In this regard, the 1986 Act defines laboratories broadly and thus allows agencies a lot of latitude in how they define the laboratory.

For example, the Agricultural Research Service was defined by the Department of Agriculture as a laboratory, but did not consider as laboratories for the purposes of the Act, the Service's approximately 120 research laboratories and facilities. Agriculture officials said that most of these laboratories and research facilities are small and do not have the expertise or resources needed to enter into cooperative agreements.

NASA and the Navy were the only agencies that did not delegate authority to their laboratories. NASA historically has worked with industry using agreements entered into under the Space Act of

1958. As allowed by the 1986 Act, NASA opted to continue its technology transfer activities under its existing authority and, therefore, has taken little action under the authority of the '86 Act.

Navy officials said it has not delegated authority to enter into cooperative agreements because its laboratories do not have the expertise to address liability issues that might arise. Without established procedures, the Navy official said that the laboratories lack the legal capabilities to ensure that the government's interests are protected. These officials added that after the laboratories have more experience with cooperative research and development agreements, the Navy might delegate such authority to its laboratories.

In summary, we—at the 25 laboratories that we visited, 15 had not delegated—had delegated authority to enter into agreements, while 10 laboratories were either not considered to be individual labs under the Act or their respective agencies had not delegated such authority to the laboratory level.

The 12 agencies we contacted reported, as part of their fiscal year 1989 budget submissions to the Office of Management and Budget and their appropriation committee, that they had entered into a total of 1200 agreements in each of fiscal years 1987 and 1988. However, the 1986 Act provides agencies flexibility in defining what is a cooperative agreement and we found that agencies were reporting different types of agreements because of the confusion of what could be covered under that particular reporting mechanism.

For example, some agencies include cooperative agreements entered into under the authority of their respective authorizing acts, while others did not. They only included what was provided for under the '86 Act.

As of February, 1989, the 12 agencies contacted reported entering into a total of 172 agreements under the 1986 Act.

The agencies with the most agreements were the Department of Agriculture, the National Institutes of Health, the National Institute of Standards and Technology, and I should note that these agencies had prior experience working with the private sector in other industry activities prior to the 1986 Act, which I think it made it easier for them to get off and run a lot quicker than maybe some of the other agencies.

The agencies contacted had taken some actions to implement the Act's incentive provisions. The Act, as amended, requires that agencies distribute at least 15 percent of royalties and other income, such as licensing fees, up to a maximum of $100,000 a year per person per invention to Federal inventors and others that assign rights to inventions or intellectual property to the Federal Government.

From 1986 through September, 1988, nine agencies collected about $4.6 million from royalties and licensing fees. These agencies had distributed or plan to distribute to the Federal inventor at least 15 percent of the royalties collected. The three agencies that had not yet collected any royalties—each planned to distribute at least 15 percent to the Federal inventors once royalties are collected.

The National Institutes of Health collected the most royalties, about 3.9 million. This amount was for agreements made prior to the 1986 Act, primarily for the National Cancer Institute's AIDS-related inventions. No royalties had been collected to date for inventions made as part of the 1986 Act agreements because, according to NIH officials, it generally takes two to three years for inventions to be made to reach the commercial marketplace.

The Agricultural Research Service has established a new cash awards program focused primarily on technology transfer. The Service established the program in September of 1988 and plans to make its first initial awards sometime this month.

Other agencies are relying on their existing cash awards program to reward their employees for promoting technology transfer. Agencies disseminate information on these programs, as well as the possibility of royalties, through formal and informal mechanisms such as internal directives, memoranda, newsletters and scientific meetings.

With regard to the mandated reports, we found that agencies had submitted to the Congress all but one of the reports mandated by the '86 Act. The only exception is the Commerce's first biennial report to the President and the Congress on the Act's implementation. Commerce has prepared a draft report, which is presently undergoing final review at the department.

In April, 1988, the Federal Laboratory Consortium for Technology Transfer issued a report to the Congress and the Federal agencies that contributed funds to its program. In May, 1988, the Secretary of Commerce issued a report dealing with various software issues. These reports cite numerous examples of technology transfer activities and portray the implementation of the '86 Act in a very positive light.

The agencies reported their activities performed in carrying out the Act's technology transfer provisions in their fiscal year 1989 budget materials submitted to the Office of Management and Budget and their appropriations subcommittee. However, as I mentioned earlier, the reports do not provide uniform statistical information that can be aggregated to show the impact of the Act on technology transfer activities.

Mr. Chairman, this concludes our statement. We would be pleased to respond to any questions you or members of the subcommittee might have.

[The prepared statement of Mr. Ols follows:]

United States General Accounting Office

GAO

Testimony

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Implementation Status of the Federal Technology Transfer Act of 1986

Statement of
John M. Ols, Jr., Director
Resources, Community, and Economic Development
Division

Before the
Subcommittee on Science, Research, and
Technology
Committee on Science, Space, and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss our just released report on the Implementation Status of the Federal Technology Transfer Act of 1986. This report was prepared at the request of the Chairman and Ranking Minority Member of the Committee on Science, Space, and Technology. As requested, it provides information on the progress that 12 federal agencies and 25 of their laboratories have made in implementing the act. The agencies and laboratories included in our study are listed in attachment I.

I would like to summarize the key aspects of the act that we examined. Federal agencies have taken numerous actions to implement the Federal Technology Transfer Act of 1986. Ten of the agencies we contacted had delegated authority to their laboratories to enter into cooperative research and development agreements. As of February 1989, the agencies contacted had entered into a total of 172 agreements under the specific authority of the 1986 act, in addition to agreements some agencies continued to enter into under their respective authorizing acts. As required by the act, each of the agencies either had distributed or planned to distribute to federal inventors at least 15 percent of the royalties collected; and one agency had established a new cash awards program focused solely on technology transfer. The Department of Commerce has drafted its first biennial report on the extent to which federal agencies have implemented the 1986 act. The agencies have submitted all other reports required by the act to date.

GAO believes it is too early to determine the impact the act has had on technology transfer. Further, although agencies reported undertaking numerous technology transfer activities, the reported activities are defined differently and, consequently, uniform statistical information has not been available to make a comprehensive evaluation. To resolve this problem and facilitate evaluating the impact of the act on technology transfer, we are conducting a separate review to develop criteria for reporting technology transfer activities. The status of this work is presented in attachment II.

KEY ASPECTS OF THE FEDERAL TECHNOLOGY TRANSFER ACT OF 1986

Before discussing the details of our work I would like to present some background on the act.

As you know, the Federal Technology Transfer Act amended the Stevenson-Wydler Technology Innovation Act of 1980 to permit federal agencies to delegate authority to government-operated laboratories to enter into cooperative research and development agreements with entities in both the public and private sector.[1] Under such an agreement, one or more federal agencies, through their laboratories, collaborate with one or more nonfederal parties in conducting specified research and development efforts that are consistent with the laboratories' missions. The act sought to make entering into such agreements as easy as possible, while protecting the legitimate concerns of the government.

To provide incentives for federal employees to promote technology transfer, the act also established royalty sharing for federal inventions and directed agencies to provide cash awards focused on technology transfer. In addition, the act contains a number of reporting requirements, including a biennial report from the Secretary of Commerce on the agencies' implementation of technology transfer legislation. The act requires the Federal Laboratory Consortium for Technology Transfer, which it formally established to help federal laboratories transfer technologies, to annually report its activities and expenditures to the Congress.

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[1] The 1986 act made agency delegation of authority to laboratory directors permissive. Executive Order 12591, April 10, 1987, as amended, states that agencies shall, within overall funding allocations and as permissible by law, delegate authority to their laboratories to enter into cooperative research and development agreements.

Further, the Secretary of Commerce had to submit a one-time report to the President and the Congress on various computer software issues, such as copyrights of federal software. Finally, each agency was required to include in its annual budget submission to the Congress a report on its technology transfer activities.

DELEGATION OF AUTHORITY TO ENTER INTO COOPERATIVE AGREEMENTS

Ten of the 12 agencies we contacted had delegated authority to their laboratories to enter into cooperative agreements. In making the delegations, however, some agencies defined laboratories to be headquarters offices at higher organizational levels than field laboratories or research centers. In this regard, the 1986 act defines laboratories broadly, and thus allows agencies a lot of latitude in how they define a laboratory. For example, the Department of Agriculture considered its Agricultural Research Service as a laboratory, but did not consider as laboratories the Service's approximately 120 research laboratories and facilities. Agriculture officials said that most of these laboratories and research facilities are small and do not have the expertise or resources needed to enter into cooperative agreements.

NASA and the Navy were the only agencies that did not delegate authority to their laboratories. NASA historically has worked with industry using agreements entered into under the Space Act of 1958. As allowed by the 1986 act, NASA opted to continue its technology transfer activities under its Space Act authority and therefore has taken little action under the authority of the 1986 act. Navy officials said it has not delegated authority to enter into cooperative agreements because its laboratories do not have the expertise to address liability issues that might arise. Without established procedures, the Navy officials said that the laboratories lack the legal capabilities to ensure that the government's interests are protected. These officials added that after the laboratories have more experience with cooperative research and development agreements, the Navy might delegate such authority to its laboratories.

Of the 25 laboratories included in our study 15 had been delegated authority to enter into cooperative agreements, while 10 laboratories were either not considered to be laboratories or their respective agencies had not delegated such authority to the laboratory level.

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS

The 12 agencies we contacted reported, as part of their fiscal year 1989 budget submissions to the Office of Management and Budget and their appropriation subcommittees, that they had entered into a total of over 1,200 agreements in each of fiscal years 1987 and 1988. However, the 1986 act provides agencies flexibility in defining what a cooperative agreement is, and we found that the agencies were reporting different types of agreements. For example, some agencies included cooperative agreements entered into under the authority of their respective authorizing acts, while other agencies included only those agreements entered into under the 1986 act. As of February 1989, the 12 agencies contacted reported entering into a total of 172 agreements under the 1986 act. (See attachment III.) The agencies with the most agreements were the Department of Agriculture, the National Institutes of Health, and the National Institute of Standards and Technology. I should note that these agencies had experience in using similar types of cooperative agreements with industry before the 1986 act was passed.

INCENTIVES TO FEDERAL EMPLOYEES

The agencies contacted had taken some actions to implement the act's incentive provisions. The act, as amended, requires that agencies distribute at least 15 percent of royalties and other income, such as licensing fees, up to a maximum of $100,000 a year per person, to federal inventors and others that assign rights to inventions or intellectual property to the federal government. From October 1986 through September 1988, nine agencies collected about $4.6 million from royalties and licensing fees. (See attachment IV.) These agencies had distributed or planned to distribute to the federal inventor at least 15 percent of the royalties collected. The three agencies that had not yet collected any royalties each planned to distribute at least 15 percent to federal inventors once royalties are collected.

The National Institutes of Health collected the most royalties, about $3.9 million. This amount was for agreements made prior to the 1986 act; primarily for the National Cancer Institute's AIDS-related inventions. No royalties had been collected to date for inventions made as part of the 1986 act agreements because, according to a National Institutes of Health official, it generally takes at least 2 to 3 years for inventions to be made and to reach the commercial marketplace.

The Agricultural Research Service has established a new cash awards program focused on technology transfer. The Service established the program in September 1988 and plans to make its initial awards sometime this month. Other agencies are relying on their existing cash awards program to reward their employees for promoting technology transfer. Agencies disseminate information on these programs, as well as the possibility of royalties, through formal and informal mechanisms such as internal directives, memoranda, newsletters, and scientific meetings.

STATUS OF MANDATED REPORTS

Agencies have submitted to the Congress all but one of the reports mandated by the 1986 act. The only exception is Commerce's first biennial report to the President and the Congress on the act's implementation. Commerce has prepared a draft report, which is presently undergoing final review at the Department.[2] In April 1988, the Federal Laboratory Consortium for Technology Transfer issued a report to the Congress and the federal agencies that contributed funds to the consortium.[3] In May 1988, the Secretary of Commerce issued a report to the President and the Congress on various software issues.[4] These reports cite numerous examples of technology transfer activities and portray the implementation of the 1986 act in a positive light.

The agencies reported their activities performed in carrying out the act's technology transfer provisions in their fiscal year 1989 budget materials submitted to the Office of Management and Budget and their appropriation subcommittees. However, as I mentioned with respect to cooperative agreements, the reports do not provide uniform statistical information that can be aggregated to show the impact of the act on technology transfer activities.

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[2] Commerce's draft report is entitled The Federal Technology Transfer Act: The First Two Years.

[3] Activities of the Federal Laboratory Consortium for Technology Transfer, Federal Laboratory Consortium for Technology Transfer, April 25, 1988.

[4] Barriers to the Commercialization of Federal Computer Software and Feasibility and Cost of Compiling an Inventory of Federally Funded Training Software, Department of Commerce, May 1988.

Mr. Chairman, this concludes my statement. We would be pleased to respond to any questions you or Members of the Subcommittee may have.

AGENCIES AND LABORATORIES INCLUDED IN THIS STUDY

Agency/Laboratory	Location
Agricultural Research Service	
Agricultural Research Service[a]	Beltsville, MD
Western Regional Research Center[b]	Berkeley, CA
National Institute of Standards and Technology	
Office of Research and Technology Assistance[a]	Gaithersburg, MD
National Oceanic and Atmospheric Administration	
Satellite Applications Laboratory[b]	Camp Springs, MD
Environmental Protection Agency	
Air and Energy Engineering Research Laboratory	Triangle Park, NC
Health Effects Research Laboratory	Triangle Park, NC
Energy	
Morgantown Energy Technology Center	Morgantown, WV
Pittsburgh Energy Technology Center	Pittsburgh, PA
National Institutes of Health	
National Cancer Institute	Silver Spring, MD
National Institute for Aging	Bethesda, MD
Air Force	
Air Force Wright Aeronautical Laboratories	Dayton, OH
Army	
Harry Diamond Laboratories	Adelphi, MD
Army Engineer Topographic Laboratories	Ft. Belvoir, VA
Army Ballistic Research Laboratory	Aberdeen, MD
Letterman Army Institute of Research	San Francisco, CA
Navy	
Naval Research Laboratory	Washington, DC
Naval Ocean Systems Center	San Diego, CA
Naval Air Test Center[b]	Patuxent River, MD
Naval Surface Weapons Center	Silver Spring, MD
Naval Underwater Systems Center	New London, CT
Bureau of Mines	
Bureau of Mines[a]	Washington, DC
Pittsburgh Research Center[b]	Pittsburgh, PA
U.S. Geological Survey	
USGS National Center[a]	Reston, VA
USGS Western Region[b]	Menlo Park, CA
National Aeronautics and Space Administration	
Lewis Research Center	Cleveland, OH

[a] For purposes of the Federal Technology Transfer Act of 1986, these headquarters offices are considered by their respective agencies to be laboratories.

[b] For purposes of the act, agencies did not consider these research facilities to be laboratories.

DEVELOPMENT OF TECHNOLOGY TRANSFER REPORTING CRITERIA

In a September 1988 letter, the House Committee on Science, Space, and Technology asked us to develop criteria for reporting on technology transfer activities. The Committee made this separate request to help resolve reporting problems that we uncovered during the early phases of our review of the implementation of the Federal Technology Transfer Act of 1986. Currently, federal agencies that operate or direct one or more federal laboratories are required by the 1986 act to report on their activities implementing the act's technology transfer provisions. For the past 2 fiscal years, agencies have submitted these reports to the Office of Management and Budget.

Problems surfaced in the interpretation of the data contained in these reports largely for two reasons (1) some officials responsible for responding to the Office of Management and Budget's request for information on technology transfer activities found the terms used in the request are ambiguous, and (2) reporting instructions regarding exactly what data to include in agencies' calculations have not been made clear. For example, some officials responsible for preparing these reports were uncertain about what technology transfer activities to include when calculating funds devoted to technology transfer or estimating the value of cooperative research and development agreements (CRDAs). An Office of Management and Budget official indicated that the agency did not expect good or complete data from the first year's reports and that it would take at least 2 years for the data to stabilize. However, reporting problems are not likely to disappear unless an effort is made to dispel ambiguities in the guidance for report preparation.

In April 1988, the Congress requested agencies and selected laboratories to provide detailed information on the steps they had taken to implement the technology transfer legislation.[1] As with the reports to the Office of Management and Budget, the written responses from the agencies and selected laboratories proved, overall, to be difficult to interpret.

To respond to the Committee's request for criteria for laboratory reporting, it was necessary to develop comparable, valid, reliable, and reportable measures of the impact of recent legislation on laboratory technology transfer activities. Therefore, we reviewed technology transfer literature and analyzed the major technology transfer legislation since 1980.[2] We also analyzed the responses prepared by departments and laboratories to the set of questions from the Congress, and fiscal year 1989 Office of Management and Budget reports. In addition, we conducted interviews with department or agency technology transfer officials.[3]

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[1] This information was requested by the Chairman, Senate Committee on Commerce, Science and Transportation and the Chairman, House Subcommittee on Science, Research and Technology.

[2] Specifically, we analyzed the Stevenson-Wydler Technology Innovation Act of 1980 (P.L. 96-480); the Federal Technology Transfer Act of 1986 (P.L. 99-502); Executive Order 12591, "Facilitating Access to Science and Technology"; the Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418); the Bayh-Dole Act (P.L. 96-517); and various conference reports associated with legislation.

After analyzing the data collected in the activities discussed above, and accounting as much as possible for differences across laboratories, we structured the criteria as a questionnaire for laboratory directors. The questionnaire was submitted for comment to approximately 70 reviewers outside GAO, including department, agency, and laboratory technology transfer officials and university technology transfer experts. It was then further modified on the basis of comments received from reviewers and pretested during April and May 1989 to develop additional information necessary to ready the questionnaire for implementation.[4]

The questionnaire we have developed has several characteristics. First, it includes precise definitions of terms that may affect the type of data reported. These definitions should allow department and laboratory officials to provide valid, reliable, and comparable data. Second, it is divided into two parts: a 5-section laboratory-level questionnaire, targeted to respondents in various laboratory units, and an agency-level questionnaire, to be answered by agencies or departments. In this way, we should obtain the information needed from the respondents best able to provide it. Third, it includes questions not asked by the Office of Management and Budget or Commerce for their reports, but that help develop a more complete picture of the impact of legislation on technology transfer activities. As such, it should produce more comprehensive information than has been available to date.

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[3] We interviewed officials at the following Departments: Agriculture (specifically the Agricultural Research Service), Defense, the Army, the Air Force, the Navy, Transportation, Interior (specifically the Bureau of Mines and USGS), Commerce, Energy, Veteran's Affairs, and Health and Human Services (specifically NIH); and at EPA and NASA. We also interviewed officials at the Office of Management and Budget, the National Science Foundation, and the FLC. We conducted these interviews to obtain their views and suggestions for developing criteria and to determine what information they need on technology transfer activities.

[4] As agreed to with the Committee, the questionnaire is expected to be implemented at the beginning of the next fiscal year to enable collection of complete fiscal year 1989 data.

The GAO-developed questionnaire is designed to provide comprehensive and uniform data to (1) aid congressional oversight of laboratory and department technology transfer activities and programs and (2) enhance the ability of departments and laboratories to manage and evaluate their technology transfer programs.

NUMBER OF CRDAS, BY AGENCY, AS OF FEBRUARY 1989

Agency	Number of CRDAs
Agricultural Research Service	59
NIST	37
NOAA	0[a]
Air Force	8
Army	12
Navy	1
Energy	0[b]
EPA	1
Bureau of Mines	1[c]
USGS	5[d]
NASA	0[e]
NIH	48

[a] According to a NOAA official, NOAA had not entered cooperative agreements with the private sector prior to the 1986 act and is proceeding cautiously. As of April 1989, NOAA was developing procedures for pursuing CRDAs and had one potential CRDA in process.

[b] Since 1986 the Department of Energy's energy technology centers have entered into 12 cooperative agreements, but these were not negotiated under the authority of the Federal Technology Transfer Act.

[c] The Bureau of Mines entered into about 180 other cooperative agreements under its authorizing legislation.

[d] USGS entered into about 900 other cooperative agreements under its authorizing legislation.

[e] From October 1986 to February 1989, NASA entered into about 108 agreements under the Space Act.

ROYALTIES COLLECTED AND DISTRIBUTED

Table IV.1: Royalties Collected by Agencies, October 1986 to September 1988

Agency	Amount collected
Agricultural Research Service	$ 213,416
NIST	104,312
NOAA	11,492
Air Force	57,244
Army	28,535
Navy	20,048
Energy/Fossil Energy[a]	0
EPA	0
Bureau of Mines[b]	54,000
USGS	0
NASA[c]	181,760
NIH	3,946,263
Total	$4,617,070

[a] The zero is for the Department of Energy's Office of Fossil Energy, which is responsible for the government-operated energy technology centers. Other entities within the Department of Energy collected royalties totaling about $881,000 for this period, but this amount was not subject to distribution under the 1986 act because the inventions were made by contractors.

[b] Bureau of Mines estimate.

[c] The amount shown for NASA is for the period October 1986 through December 1988.

Source: Prepared by GAO from data provided by the agencies.

Table IV.2 shows the royalties distributed by percent from October 1986 through September 1988 by the agencies we examined.

Table IV.2: Distribution of Royalties, October 1986 to September 1988

Agency	Percent distributed Inventors	Offset expenses	Laboratories	Treasury
Agricultural Research Service	15	85	0	0
NIST	15	52	33	0
NOAA	15	85	0	0
Air Force[a]	0	0	0	0
Army[a]	0	0	0	0
Navy[b]	48	0	52	0
Energy/Fossil Energy[c]	0	0	0	0
EPA[d]	0	0	0	0
Bureau of Mines	15	35	50	0
USGS[e]	0	0	0	0
NASA[f]	65	0	24	11
NIH[g]	17	29	54	0

[a] The Air Force and the Army had not distributed any royalties collected as of February 1989. Each of these military services held the funds in an escrow account and planned to distribute to inventors the greater of the first $1,000 or 20 percent of the royalties collected annually for each invention.

[b] The Navy distributes to each inventor the greater of the first $1,000 or 20 percent of the royalties collected annually for each invention.

[c] The Department of Energy's Office of Fossil Energy had not collected any royalties during the period, but it planned to distribute to the inventors 15 percent of any future royalties collected.

[d] EPA had not collected any royalties during the period, but it had established a royalty program providing for inventors to receive about 35 percent of any future royalties collected.

[e] USGS had not collected any royalties during the period, but it planned to distribute to the inventors 15 percent of any future royalties collected.

[f] Percentages shown for NASA are for calendar years 1987-88. NASA provides its inventors the first $2,000 of royalties collected and 20 percent of the royalties in excess of the first $2,000. Remaining royalties are generally distributed to the field installations where the invention was made. However, if the amount to the field installation exceeds 5 percent of its budget, 25 percent of the excess is distributed to the field installations and 75 percent of the excess is paid to the Treasury.

[g] Fiscal year 1988 royalty data provided by NIH showed amounts distributed to inventors, but did not show other distributions. Percentages shown are for fiscal year 1987 distributions.

Source: Prepared by GAO from data provided by the agencies.

United States General Accounting Office

GAO

Report to Congressional Requesters

May 1989

TECHNOLOGY TRANSFER

Implementation Status of the Federal Technology Transfer Act of 1986

Printed copies of this document will be available shortly.

GAO Form 171 (12/87)

GAO
**United States
General Accounting Office
Washington, D.C. 20548**

**Resources, Community, and
Economic Development Division**

B-233794

May 30, 1989

The Honorable Robert A. Roe
Chairman, Committee on Science, Space,
and Technology
House of Representatives

The Honorable Robert S. Walker
Ranking Minority Member,
Committee on Science, Space,
and Technology
House of Representatives

In your letter of June 17, 1988, you requested us to examine the implementation of the Federal Technology Transfer Act of 1986 (P.L. 99-502). Technology transfer is the movement of federally owned or originated technology from one organization, area, or purpose to another. The act promotes technology transfer from federal laboratories primarily by (1) permitting federal agencies to delegate authority to government-operated laboratories to enter into cooperative research and development agreements with entities in both the public and private sector and (2) providing federal employees incentives to promote technology transfer.

As requested by your letter and subsequently agreed to with your office, we obtained information on the implementation of several key aspects of the act at 12 federal agencies and 25 of their laboratories. Key aspects of the act that we examined included agencies' delegation of authority to laboratories to enter into cooperative research and development agreements, the number of such agreements entered into, incentives provided to government employees to promote technology transfer, and the status of reports mandated by the act.

RESULTS IN BRIEF

Federal agencies have taken numerous actions to implement the Federal Technology Transfer Act of 1986. Ten of the agencies we contacted had delegated authority to their laboratories to enter into cooperative research and development agreements. As of February 1989, the agencies contacted had entered into a total of 172 agreements under the specific authority of the 1986 act, in addition to agreements some agencies continued to enter into under their respective authorizing acts. As required by the act, each of the agencies either had distributed or planned to distribute to federal inventors at least 15 percent of royalties collected; and one agency had established a new cash awards program focused solely on technology transfer. The Department of Commerce has drafted its first biennial report on the extent to which federal agencies have implemented the 1986 act. The agencies have submitted all other reports required by the act to date.

We believe it is too early to determine the impact the act has had on technology transfer. Further, although agencies reported undertaking numerous technology transfer activities, the activities are defined differently and, consequently, uniform statistical information has not been available to make a comprehensive evaluation. To resolve this problem and facilitate evaluating the impact of the act on technology transfer, we are conducting a separate review to develop criteria for reporting technology transfer activities.[1]

BACKGROUND

The Federal Technology Transfer Act of 1986 provided agencies with considerable flexibility in how they could implement the act. It permitted but did not require, agencies to delegate to their laboratories authority to enter into cooperative research and development agreements.[2] The Congress expected that the act would make entering into these agreements as easy as possible, while protecting the government's interests. As incentives for technology transfer, the act established royalty sharing for federal inventions and directed agencies to provide cash awards.

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[1] This review is being performed by our Program Evaluation and Methodology Division.

[2] Although the 1986 act made agency delegation of authority to laboratory directors permissive, Executive Order 12591, April 10, 1987, as amended, states that agencies shall, within overall funding allocations and as permissible by law, delegate authority to their laboratories to enter into cooperative research and development agreements.

The act also mandated that the Department of Commerce report biennially and each agency with government-operated laboratories report annually to the Congress on technology transfer activities conducted under the act.

DELEGATION OF AUTHORITY TO ENTER INTO COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS

Of the 12 agencies we contacted, 10 had delegated authority to their laboratories to enter into cooperative research and development agreements. In making the delegations, some agencies defined laboratories to be headquarters offices, which are at higher organizational levels than field laboratories or research centers. For example, the Department of Agriculture considered its Agricultural Research Service a laboratory--not the Service's approximately 120 research laboratories and facilities. According to Agriculture officials, most of these entities are small and lack the expertise or resources needed to enter into the agreements.

The two agencies that did not delegate such authority to their laboratories were the National Aeronautics and Space Administration (NASA) and the Navy. NASA historically has worked with industry using collaborative agreements entered into under the Space Act of 1958 and was the only federal agency to have a technology transfer mission at the time of the 1986 act.[3] NASA opted to continue its technology transfer activities under its Space Act authority and therefore has taken little action under the authority of the 1986 act.[4] According to Navy officials, the Navy has not delegated any authority to enter into agreements because its laboratories do not have the expertise to address liability issues that might arise. These officials added that after the laboratories have more experience with cooperative research and development agreements, the Navy might delegate such authority to its laboratories.

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[3] See Congressional Research Service Issue Brief IB85031, Technology Transfer: Utilization of Federally Funded Research and Development, April 14, 1988.

[4] The 1986 act's cooperative research and development agreement provision was not intended to limit or diminish existing authorities of any agency.

Of the 25 laboratories included in our study, 15 had been delegated authority to enter into agreements. Of the 10 not delegated such authority, 5 were not considered to be laboratories by their respective agencies and the other 5 were either NASA or Navy laboratories. (See app. II.)

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS

The 12 federal agencies we contacted had reported to the Office of Management and Budget and the cognizant appropriations subcommittees that they had entered into a total of over 1,200 cooperative research and development agreements in each of fiscal years 1987 and 1988. However, the 1986 act provides agencies flexibility by broadly defining a cooperative research and development agreement, and we found that they were reporting different types of agreements. For example, some agencies included agreements entered into under the authority of their respective authorizing acts, while other agencies included only those agreements entered into under the specific authority of the 1986 act. As of February 1989, the agencies had entered into a total of 172 agreements specifically under the authority of the 1986 act. The Agricultural Research Service, which over the years has worked closely with the private sector, was the first to enter into an agreement under the 1986 act and, as of February 1989, had the most--59 agreements. Others with a large number of agreements were the National Institutes of Health (48) and the National Institute of Standards and Technology (37). (See app. III for a list of the numbers per agency.)

Agencies that had not entered into similar agreements prior to the act have begun entering into cooperative research and development agreements. For example, the Air Force signed its first agreement in September 1988 and, as of February 1989, had entered into eight agreements and was processing another nine. (See app. III.)

INCENTIVES TO FEDERAL EMPLOYEES

The agencies we contacted had taken some actions to implement the act's incentive provisions. The act, as amended, requires that agencies distribute at least 15 percent of royalties and other income, such as licensing fees, to federal inventors and others that assign rights to inventions or intellectual property to the federal government.[5] This provision applies to all royalties or other income collected since the date of the act, October 20, 1986.

From October 1986 through September 1988, nine of the agencies collected a total of about $4.6 million in royalties.[6] These agencies had distributed or planned to distribute to the federal inventor at least 15 percent of the royalties they collected. The three agencies that had not yet collected any royalties each planned to distribute at least 15 percent to federal inventors.

The National Institutes of Health collected the most royalties, about $3.9 million, which were for agreements made prior to the 1986 act and were primarily for the National Cancer Institute's acquired immune deficiency syndrome-related inventions. A National Institutes of Health official explained that no royalties had been collected to date for inventions made as part of cooperative research and development agreements because it generally takes at least 2 to 3 years for inventions to be made and to reach the marketplace.

The Agricultural Research Service has established a new cash awards program focused on technology transfer. The Service established the program in September 1988 and plans to make its initial awards in June 1989. Other agencies relied on their existing cash awards program to reward their employees for promoting technology transfer. These programs, as well as the possibility of royalties, are publicized to employees through various formal and informal mechanisms. (See app. IV.)

MANDATED REPORTING

Agencies have submitted to the Congress most of the reports mandated by the 1986 act. In April 1988, the Federal

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[5] Agencies can establish an alternative royalty sharing program that, among other things, provides at least 15 percent of total agency royalties in any fiscal year to all such inventors.

[6] Royalties collected include licensing fees and are not necessarily for agreements made under the authority of the 1986 act.

Laboratory Consortium for Technology Transfer[7] issued to the Congress, and to the federal agencies that contributed funds to the consortium, a report entitled Activities of the Federal Laboratory Consortium for Technology Transfer. In May 1988, the Secretary of Commerce issued to the President and the Congress its report: Barriers to the Commercialization of Federal Computer Software and Feasibility and Cost of Compiling an Inventory of Federally Funded Training Software. As of May 1989, Commerce, with input from the various federal agencies, had under final review a draft of its first biennial report[8] to the President and the Congress on the implementation of the act. These reports cite numerous examples of technology transfer activities and portray the implementation of the 1986 act in a positive light.

The act also requires each federal agency that operates or directs one or more federal laboratories to include in its annual budget submission to the Congress a report on the activities performed in carrying out the act's technology transfer provisions. For fiscal year 1989, the agencies included their reports in budget materials submitted to the Office of Management and Budget and the cognizant appropriations subcommittees. The agencies' reports provided information on their respective technology transfer activities. However, as we mentioned with respect to cooperative research and development agreements, the agencies used different definitions; consequently the reports do not provide uniform statistical information.

CONCLUSIONS

Federal agencies have taken numerous actions to implement the 1986 act, but we believe that it is too early to determine what impact the act has had on technology transfer. In this regard, its effect on commercial products has not yet occurred because it takes at least 2 to 3 years for inventions to be made and to reach the marketplace. Even though the agencies had entered into 172 agreements specifically under the authority of the 1986 act, royalties have not yet resulted from them. Further, for purposes of entering into cooperative research and development agreements, the act defines laboratories and such agreements broadly, thereby allowing agencies considerable flexibility in implementing the act. Because agencies have made different interpretations, the technology transfer activities reported by agencies and laboratories represent different activities and uniform statistical information has not been available to make a comprehensive evaluation. To resolve this problem and facilitate evaluating the impact of the act on technology transfer, we are conducting a separate review to develop criteria for reporting technology transfer activities. (See app. IX.)

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[7] The Federal Laboratory Consortium for Technology Transfer is a networking organization to promote technology transfer. More than 300 federal laboratories and research centers, representing 14 federal agencies, are members.

[8] Commerce's draft report is entitled The Federal Technology Transfer Act: The First Two Years.

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In preparing this report, we interviewed headquarters officials at 12 federal agencies that have government-owned and -operated laboratories and technology transfer officials at 25 of their laboratories, including some at both large and small laboratories. Background information on the 1986 act; our objectives, scope, and methodology; and a list of the agencies and laboratories contacted in our study are presented in appendix I.

You asked us to provide, in addition to the information on key aspects of the act discussed above, a brief description of the agencies' Offices of Research and Technology Applications and agencies' and laboratories' views on barriers to the act's implementation, the Federal Laboratory Consortium for Technology Transfer, and incentives for seeking foreign patents. These issues are discussed in appendixes V through VIII.

We discussed the information included in this report with agency officials, who agreed with the accuracy of the facts presented. However, as requested by your office, we did not obtain official agency comments on this report. We did not fully verify the statistical information the agencies provided. Our review was performed in accordance with generally accepted government auditing standards between June 1988 and March 1989.

Major contributors to this report are listed in appendix X. If we can be of further assistance, please contact me at (202) 275-5525.

John M. Ols, Jr.

John M. Ols, Jr.
Director, Housing and
Community Development Issues

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ABBREVIATIONS

CRDA	cooperative research and development agreement
EPA	Environmental Protection Agency
FLC	Federal Laboratory Consortium for Technology Transfer
GAO	General Accounting Office
NASA	National Aeronautics and Space Administration
NIH	National Institutes of Health
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NTIS	National Technical Information Service
ORTA	Office of Research and Technology Applications
R&D	research and development
USGS	U.S. Geological Survey

BACKGROUND AND OBJECTIVES, SCOPE, AND METHODOLOGY

BACKGROUND

In carrying out their respective missions, federal agencies annually spend billions of dollars for research and development (R&D). In fiscal year 1988, the federal government spent about $63 billion on R&D, of which about $16 billion was for R&D at federal laboratories. These laboratories are a potential source of technology, technical expertise, and techniques that may have commercial application. The commercialization of these technologies is the responsibility of private industry, however, not the federal government. The movement of federally owned or originated technology from federal laboratories to industry and/or state and local governments is achieved through technology transfer--a process by which technology developed in one organization, in one area, or for one purpose is applied and used in another organization, in another area, or for another purpose.[1]

Stevenson-Wydler Act of 1980

As concerns grew about U.S. competitiveness during the 1970s, the Congress began questioning whether the federal government was receiving an adequate return from its R&D expenditures. The Congress passed the Stevenson-Wydler Technology Innovation Act of 1980 (15 U.S.C. 3701 *et seq.*), making technology transfer part of the mission of all federal agencies carrying out R&D.[2] This act also required federal agencies to establish at laboratories[3] an Office of Research and Technology Applications (ORTA) that would identify technologies and ideas with potential applications in other settings.

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[1] For a more detailed definition of technology transfer, see *Technology Transfer: Utilization of Federally Funded Research and Development*, Issue Brief IB85031, Congressional Research Service, April 14, 1988.

Key Aspects of the Federal Technology Transfer Act of 1986

The Federal Technology Transfer Act of 1986 (P.L. 99-502) amended the Stevenson-Wydler Act to permit federal agencies to delegate authority to government-operated laboratories to collaborate with other agencies, private industry, state and local governments, and nonprofit organizations through cooperative R&D agreements (CRDA).[4] The definition of a CRDA is broad. Under a CRDA, one or more federal agencies, through its laboratories, may provide personnel, services, facilities, equipment, or other resources (but not funds), with or without reimbursement, to one or more nonfederal parties who, in turn, may provide funds, personnel, services, facilities, equipment, or other resources toward the conduct of specified R&D efforts that are consistent with the laboratories' missions. The act sought to make entering into such CRDAs as easy as possible, while protecting the legitimate concerns of the government. The act's legislative history indicates that CRDAs were not expected to disseminate restricted information or to transfer classified technologies. Although the act states that a CRDA is not a procurement contract, agencies may adopt as many provisions of the Federal Acquistion Regulations as they deem appropriate.

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[2] At the time this act was passed, according to the Congressional Research Service, the National Aeronautics and Space Administration (NASA) was the only federal agency that had technology transfer as part of its mission.

[3] The act originally required that an ORTA be established at each laboratory with an annual budget of $20 million or more. The 1986 act amended this, requiring laboratories with 200 or more full-time-equivalent scientific, engineering, and related technical positions to provide one or more full-time-equivalent positions as staff for their ORTAs.

[4] Although the 1986 act made agency delegation of authority to laboratory directors permissive, Executive Order 12591, April 10, 1987, as amended, states that agencies shall, within overall funding allocations and as permissible by law, delegate authority to their laboratories to enter into CRDAs.

The act allows some flexibility in how agencies may implement a CRDA. Under a CRDA, a government-operated laboratory may (1) accept, retain, and use funds, personnel, services, and properties from collaborating parties and provide the same to the collaborating parties (except no funds may be provided to nonfederal parties); (2) grant, or agree to grant in advance, to a collaborating party patent licenses or assignments of licenses for any invention made in whole or in part by a federal employee (but the government must retain nonexclusive rights to use the inventions); (3) waive, in whole or in part, any right by the federal government to an invention, except for the nonexclusive right to use the invention; (4) determine the rights to other intellectual property developed under a CRDA; and (5) consistent with agency requirements and standards of conduct, permit laboratory employees or former employees to commercialize inventions they made while in the service of the United States. Moreover, memoranda of agreement which preexisted the 1986 act may meet the definition of a CRDA as long as the agreement does not transfer federal funds to participants and is for specified R&D directed toward a laboratory mission.

To provide incentives for federal employees to promote technology transfer, the act established royalty sharing for federal inventions and directed agencies to have a cash awards program focused on technology transfer. The act directs agencies to either (1) pay an employee inventor[5] at least 15 percent of any royalties or other income received--up to $100,000 per year for an invention--or (2) establish an alternative royalty sharing program. Any agency that expends more than $50 million per fiscal year for R&D at its government-operated laboratories is required to have a cash awards program to reward its scientific, engineering, and technical personnel for inventions, innovations, other outstanding scientific or technological contributions, or exemplary activities that promote technology transfer.

The 1986 act also formally established the Federal Laboratory Consortium for Technology Transfer (FLC), which evolved from a consortium created by the Department of Defense in 1971. The FLC is a networking organization of federal laboratories and their technology transfer offices. Its purpose is to help federal laboratories transfer technologies. The 1986 act requires the FLC to annually report its activities and expenditures to the Congress.

The act contains a number of other reporting requirements. The Secretary of Commerce must submit a one-time report to the President and the Congress on copyright provisions and other legal barriers that limit the transfer of federally funded computer software and on the feasibility and cost of compiling and maintaining a current and comprehensive inventory of all federally funded training software. The Secretary of Commerce is also required to report biennially on agencies' use of Stevenson-Wydler

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[5] The National Institute of Standards and Technology Authorization Act for Fiscal Year 1989 (P.L. 100-519) amended this provision to include any inventor that assigned his or her rights in an invention to the United States.

Act authorities. Also, each agency must include in its annual budget submission to the Congress a report on its technology transfer activities and the amounts of royalties and other income received and expenditures made, including inventor awards.

OBJECTIVES, SCOPE, AND METHODOLOGY

In a letter dated June 17, 1988, the Chairman and Ranking Minority Member, House Committee on Science, Space, and Technology, asked us to examine the implementation of the Federal Technology Transfer Act of 1986 (P.L. 99-502). As requested by that letter and subsequently agreed to with your office, we obtained (1) information on agencies' delegating authority to their laboratories to enter into CRDAs, (2) the number of CRDAs entered into, (3) data on the agencies' implementation of provisions for royalties and cash awards to federal employees and on how agencies publicized their incentives programs, (4) the status of the reports mandated by the act, (5) a brief description of laboratories' ORTAs, (6) agencies' and laboratories' views on barriers to CRDAs, (7) agencies' and laboratories' views on the FLC, and (8) agencies' views on whether domestic users of federal inventions and intellectual property have sufficient authority and incentive to seek foreign patent protection.

To accomplish our objectives, we interviewed technology transfer officials at agency headquarters in Washington, D.C., and used a data collection instrument for obtaining information from officials at 25 selected laboratories.[6] Agency headquarters visited in the Washington, D.C., metropolitan area included those of the U.S. Department of Agriculture's Agricultural Research Service; the Department of Commerce and its National Institute of Standards and Technology (NIST) and National Oceanic and Atmospheric Administration (NOAA); the Department of Defense[7] and the Air Force, Army, and Navy; the Department of Energy's Office of Fossil Energy; the Department of the Interior and its Bureau of Mines and U.S. Geological Survey (USGS); the Environmental Protection Agency (EPA); the National Aeronautics and Space Administration (NASA); and the National Institutes of Health (NIH). As agreed with the requesters' offices, we selected laboratories in the Washington, D.C., metropolitan area and laboratories in other regions of the country, including large and small laboratories of interest to the requesters' offices. Laboratories included in our review are both headquarters offices designated by their respective agencies to be laboratories for the purposes of the 1986 act and relatively small field research centers not considered to be laboratories. Because the laboratories were not randomly selected, information obtained does not necessarily represent the status of implementation at other laboratories. The 12 agencies and 25 laboratories and research facilities we contacted are listed in table I.1.

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[6] The 25 laboratories were selected from research facilities listed in the Directory on Federal Laboratory and Technology Resources, 1988-1989, Center for the Utilization of Federal Technology, National Technical Information Service, Department of Commerce.

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[7] For purposes of the 1986 act, the Air Force, Army, and Navy are defined as agencies. Accordingly, the services have direct statutory authority and no action to implement the act for the services was required by the Department of Defense.

Table I.1: Agencies and laboratories Included in This Study

Agency/laboratory	Location
Agricultural Research Service	
Agricultural Research Service[a]	Beltsville, MD
Western Regional Research Center[b]	Berkeley, CA
NIST	
Office of Research and Technology Assistance, NIST[a]	Gaithersburg, MD
NOAA	
Satellite Applications Laboratory[b]	Camp Springs, MD
EPA	
Air and Energy Engineering Research Laboratory	Triangle Park, NC
Health Effects Research Laboratory	Triangle Park, NC
Energy	
Morgantown Energy Technology Center	Morgantown, WV
Pittsburgh Energy Technology Center	Pittsburgh, PA
NIH	
National Cancer Institute	Silver Spring, MD
National Institute for Aging	Bethesda, MD
Air Force	
Air Force Wright Aeronautical Laboratories	Dayton, OH
Army	
Harry Diamond Laboratories	Adelphi, MD
Army Engineer Topographic Laboratories	Ft. Belvoir, VA
Army Ballistic Research Laboratory	Aberdeen, MD
Letterman Army Institute of Research	San Francisco, CA
Navy	
Naval Research Laboratory	Washington, DC
Naval Ocean Systems Center	San Diego, CA
Naval Air Test Center[b]	Patuxent River, MD
Naval Surface Weapons Center	Silver Spring, MD
Naval Underwater Systems Center	New London, CT
Bureau of Mines	
Bureau of Mines[a]	Washington, DC
Pittsburgh Research Center[b]	Pittsburgh, PA
USGS	
USGS National Center[a]	Reston, VA
USGS Western Region[b]	Menlo Park, CA
NASA	
Lewis Research Center	Cleveland, OH

[a] For purposes of the Federal Technology Transfer Act of 1986, these headquarters offices are considered by their respective agencies to be laboratories.

[b] For purposes of the act, agencies did not consider these research facilities to be laboratories.

To obtain an overview of the status of the implementation of the 1986 act, we attended the FLC's November 1988 conference on the implementation of the Federal Technology Transfer Act. To gain a perspective on the act and the problems or barriers being encountered, we examined past reports on the subject and the act's legislative history.

To ascertain the status and problems encountered in delegating to laboratories the authority for entering into CRDAs, we spoke with officials from each agency and one or more of its laboratories. We verified that delegations had been made by obtaining copies of relevant documents.

We obtained information on the number of CRDAs entered into from the agencies and laboratories, focusing on CRDAs entered into under the authority of the 1986 act. At the time we initially interviewed agency and laboratory officials, we obtained copies and listings of CRDAs to validate that CRDAs had been entered into. However, those interviews took place at various times, and to provide more recent and consistent time frames, we obtained updates from responsible officials without further verification.

To ascertain the extent to which agencies and laboratories have implemented the royalty and cash award incentives for federal inventors, as well as publicized their incentives programs, for the period October 1986 through September 1988, we interviewed laboratory and agency officials and reviewed documents they provided.[8] However, because extensive time would be required to examine the relatively large number of accounting systems involved, we did not independently verify the accuracy of the information provided.

To ascertain the status of the reports mandated by the act, we obtained copies of the reports issued by the various agencies and discussed them with agency officials.

We obtained a brief description of laboratories' ORTAs from each agency and discussed their organization and function with each of the laboratories included in our review.

We obtained agencies' and laboratories' views on barriers to CRDAs through interviews with agency and laboratory officials. We followed up on problems or barriers mentioned in our March 1988 report.[9] To gain additional perspective, we reviewed past reports on this issue by the Congressional Research Service, Commerce, the FLC, and others.

We interviewed agency and laboratory officials for their views on the FLC. To understand the FLC's objectives and scope of activities, we also spoke with the FLC's Washington, D.C., representative and reviewed documents provided.

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[8] On October 24, 1988, the National Institute of Standards and Technology Authorization Act for Fiscal Year 1989 (P.L. 100-519) amended the royalty provision to include any inventor that assigns his or her rights to an invention to the United States. Although this provision was made retroactively effective to October 20, 1986, royalties discussed in this report are those for federal inventors.

[9] Technology Transfer: Constraints Perceived by Federal Laboratory and Agency Officials (GAO/RCED-88-116BR, Mar. 4, 1988).

We also obtained views on incentives for seeking foreign patent protection through interviews with agency officials. Because many of the agencies included in our review rely on Commerce's National Technical Information Service for obtaining patents, we interviewed patent officials at that Service and at Commerce's Patent and Trademark Office, as agreed with the requesters' offices.

We discussed the information included in this report with agency officials, who agreed with the accuracy of the facts presented. However, as instructed by the requesters' offices, we did not obtain official agency comments on this report. As noted above, we did not fully verify the information the agencies provided. Our review was performed in accordance with generally accepted government auditing standards between June 1988 and March 1989.

AGENCIES' DELEGATION OF AUTHORITY TO LABORATORIES

As of February 1989, 10 of the 12 agencies we visited had delegated authority to their laboratories to enter into CRDAs under the Federal Technology Transfer Act of 1986. Of the 25 laboratories in our study, 15 had been delegated authority to enter into CRDAs, 5 were not considered laboratories by their agencies, and 5 laboratories belonged to agencies that had not delegated CRDA authority to the laboratory level. Some of the agencies that had made delegations defined laboratories to be headquarters offices, which are at higher organizational levels than field laboratories or research centers.[1] For example, the U.S. Department of Agriculture considered its Agricultural Research Service to be a laboratory. According to Agriculture officials, the Service's approximately 120 research laboratories and facilities lack the expertise or resources needed to enter into CRDAs.

Two agencies, NASA and the Navy, have not delegated authority to their laboratories to enter into CRDAs. NASA, which had a technology transfer mission before the 1986 act was passed, historically has worked with industry using collaborative agreements entered into under its Space Act authority. NASA opted to continue its technology transfer activities under this authority rather than to delegate any authority under the 1986 act. According to Navy officials, the Navy has not delegated authority to its laboratories because, in their view, the laboratories do not have the expertise to address potential liability issues that might arise.

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[1] For provisions of the act pertaining to CRDAs, the 1986 act defines "laboratory" as a facility or group of facilities owned, leased, or otherwise used by a federal agency, a substantial purpose of which is the performance of research, development, or engineering by federal employees.

A more detailed discussion of the delegation of authority by the agencies in our study follows.

AGRICULTURE

On May 11, 1987, the Secretary of Agriculture delegated, through the respective Assistant Secretaries (Science and Education and Natural Resources and Environment), authority to enter into CRDAs to the Administrator of the Agricultural Research Service and the Chief of the Forest Service. For purposes of the Federal Technology Transfer Act of 1986, the U.S. Department of Agriculture decided that the Agricultural Research Service and the Forest Service met the definition of "laboratory." Agriculture does not believe the act intended small field activities to be entering into CRDAs and has not delegated such authority to the Agricultural Research Service's approximately 120 field locations. According to an Agriculture Research Service official, the Service's large research facility at Beltsville, Maryland, also has not been delegated authority to enter into CRDAs. This official explained that because the facility lacks the needed expertise and is located at the Service's headquarters office, Agriculture decided not to duplicate capabilities at Beltsville.

COMMERCE

National Institute of Standards and Technology

The Secretary of Commerce delegated all of the Department of Commerce's authorities under the 1986 act to the Under Secretary for Economic Affairs.[2] On January 26, 1988, the Under Secretary for Economic Affairs, delegated authority to enter into CRDAs to the Director of the National Bureau of Standards (now NIST). On March 16, 1988, the Director further delegated this authority to NIST's four major organizational units: the National Measurement Laboratory, the National Engineering Laboratory, the Institute for Materials Science and Engineering, and the National Computer Systems Laboratory.

National Oceanic and Atmospheric Administration

On March 18, 1988, the Under Secretary for Economic Affairs delegated implementation authorities of the 1986 act to the Under Secretary for Oceans and Atmosphere, who, in turn, delegated these authorities to the Chief Scientist. Subsequent delegations were issued to NOAA's Assistant Administrators for the Office of Oceanic and Atmospheric Research; the National Marine Fisheries Service; the National Ocean Service; the National Weather Service; and the National Environmental Satellite, Data, and Information Service. The Assistant Administrator for the Office of Oceanic and Atmospheric Research delegated the authority to enter into CRDAs to the only large laboratory within NOAA, the Environmental Research Laboratories, Boulder, Colorado, which has about 200 to 250 researchers. The Assistant Administrator for the National Marine Fisheries Service delegated the authority to the National Marine Fisheries Service's four regional fisheries centers. According to a NOAA official, NOAA has delegated the authority to enter into

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[2] The National Institute of Standards and Technology Authorization Act for Fiscal Year 1989 (P.L. 100-519) created the position of an Under Secretary of Commerce for Technology within the Department of Commerce. Technology transfer activities, formerly the responsibility of the Under Secretary for Economic Affairs, were transferred to the Under Secretary for Technology.

CRDAs down to the lowest practical level that has sufficient legal, administrative, and management support.

DEFENSE

Air Force

On October 31, 1988, the Air Force delegated authority to enter into CRDAs to the Commander, Air Force Systems Command, which is responsible for the Air Force's 14 laboratories. On February 4, 1989, the Command formally delegated this authority to its laboratories. The Air Force Systems Command has retained the right to disallow or modify a CRDA within 30 days after it is received.

Army

On November 4, 1987, the Secretary of the Army delegated to the Assistant Secretary of the Army (Research, Development, and Acquisition) authority to enter into CRDAs and to license, assign, or waive rights to intellectual property developed at the laboratories. The Assistant Secretary then delegated this authority to five Army Commands on December 4, 1987.

On March 31, 1988, the Army Material Command, with 22 of the 36 Army's laboratories, became the first of the Army commands to delegate CRDA authority to its laboratories. By mid-November 1988, three other Army commands--the U.S. Army Surgeon General, the U.S. Corps of Engineers, and the U.S. Army Deputy Chief of Staff for Personnel--also had delegated this authority to their respective laboratories. According to the Army, the fifth command, the U.S. Army Strategic Defense Command, does not have a laboratory.

Navy

The Navy domestic technology transfer program has been in effect over 16 years, but the early emphasis was on wide dissemination of Navy technology to all users rather than on exclusive marketing licenses to commercial organizations. According to Navy officials, the Navy has not delegated to its laboratories authority to enter into CRDAs primarily because liability issues might arise that the laboratories do not have the expertise to address; without established procedures, the laboratories lack legal capabilities to ensure that the government's interests are protected. These officials told us that after the laboratories have more experience with CRDAs (one had been entered into as of February 1989), the Navy may delegate authority to its laboratories. Pending issuance of the authority, laboratory personnel have been encouraged to pursue possible CRDAs and advised to submit any such agreement that is negotiated to the Secretary of the Navy for signature.[3]

ENERGY

The Department of Energy's two major government-owned, government-operated laboratories are the Morgantown and Pittsburgh Energy Technology Centers. These laboratories, which report to Energy's Office of Fossil Energy, have been involved over the years in many cooperative cofunded R&D projects in technologies such as synthetic fuels and clean coal. Energy indicated in its June 20, 1988, letter to the Subcommittee on Science, Research, and

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[3] About 9 months after the laboratory had submitted a proposed CRDA to Navy headquarters for review and approval, the Navy delegated authority on a one-time basis to the Director, Naval Research Laboratory, to sign the specific CRDA; the laboratory director was not delegated authority to sign other CRDAs.

Technology, House Committee on Science, Space, and Technology, that delegation of authority to the laboratories was not needed because the laboratory directors had authority to enter into CRDAs under Energy's authorizing legislation. However, on October 13, 1988, the Assistant Secretary for Fossil Energy delegated authority to the directors of the Energy Technology Centers to enter into CRDAs. The Assistant Secretary noted that the purpose of the delegation of authority was to (1) reemphasize the high priority placed on making available the results of publicly financed R&D to the private sector and (2) clarify any confusion that may have existed about the directors' authority to carry out the provisions of the Federal Technology Transfer Act.

EPA

On December 15, 1988, EPA delegated to its laboratory directors the authority to enter into CRDAs. While the delegation of authority was being developed, EPA's Administrator informed the laboratory directors that they may develop CRDAs; several CRDAs were in process at the time the delegation was made.

INTERIOR

Bureau of Mines

On May 24, 1988, the U.S. Department of the Interior delegated authority to enter into CRDAs to the Director, Bureau of Mines. For the CRDA provisions of the 1986 act, Interior considered the Bureau of Mines to be a "laboratory," and authority has not been delegated to lower-level entities.

U.S. Geological Survey

On May 24, 1988, Interior also delegated authority to enter into CRDAs to the Director, USGS. Interior also considered USGS to be a "laboratory." USGS has not made any further delegations.

NASA

NASA has not delegated authority to enter into CRDAs under the Federal Technology Transfer Act of 1986. Instead, NASA uses its Space Act authority (42 U.S.C. 2473 (c) (5) and (6)) to enter into cooperative agreements similar to those under the Federal Technology Transfer Act of 1986. Under the Space Act agreements, NASA and a U.S. individual or entity may agree to contribute to or participate in a space- or aeronautics-related project of mutual benefit. These agreements usually involve the use of each other's services, equipment, information, and/or facilities.

NASA has formally delegated authority to enter into Space Act agreements to officials in charge of NASA headquarters offices. These offices include the Associate Administrators for Aeronautics and Space Technology, External Relations, Space Flight, Space Science and Applications, Space Tracking and Data Systems, Space Station, and Commercial Programs. This delegation for agreements not involving reimbursement was last revised on January 28, 1985. The delegation authority sets forth limits such as the following: (1) each agreement will be reviewed by the NASA Comptroller, General Counsel, and Associate Administrator for External Relations; (2) NASA's investment in each agreement will not exceed $25 million; and (3) consideration for NASA's involvement requires taking into account NASA's statutory objectives and obligations and Presidential and NASA policies on U.S. efforts in space. According to NASA, a further delegation of authority to field installations was not made because of a need for accountability over available resources.

NASA made a separate delegation for Space Act agreements involving reimbursements on July 12, 1984. Under these types of agreements, participants reimburse NASA for work or services NASA performs for them. This delegation also sets forth various limitations, including a $10 million limit. The NASA laboratory we visited, the Lewis Research Center, had been delegated authority to enter into reimbursable agreements under the Space Act.

NIH

NIH established a Patent Policy Board to oversee the invention development program and to implement the 1986 act. The Patent Policy Board has established subcommittees for areas such as CRDAs, royalty distribution, data systems, and NIH-industry collaboration. On June 23, 1987, the Secretary of Health and Human Services delegated authority to carry out the activities necessary to implement the 1986 act to the Assistant Secretary for Health, who is responsible for the Public Health Service. All of the Department of Health and Human Services' research laboratories are under the Public Health Service. On February 4, 1988, the Assistant Secretary, in turn, delegated the authority to the Public Health Service agency heads, including the Director, NIH.

The Director, NIH, on March 15, 1988, delegated authority to sign CRDAs to the Director of each of NIH's 12 institutes. The Patent Policy Board's CRDAs subcommittee, acting for the Director, NIH, reviews each agreement within 30 days after it is received.

NUMBER OF COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS

The 12 federal agencies we contacted reported entering into a total of 172 CRDAs specifically under the authority of the Federal Technology Transfer Act of 1986 as of February 1989. In their 1989 budget submissions to the Office of Management and Budget and their cognizant appropriations subcommittees, the agencies reported that they had entered into a total of 1,217 CRDAs in fiscal year 1987 and another 1,285 in fiscal year 1988. In reporting these amounts, some agencies included various cooperative agreements entered into under the authority of their respective authorizing acts, while others reported only those entered into under the authority of the 1986 act. Further, some agencies included estimates of the number expected to be entered into, while others reported only agreements already entered into. For this report, we focused on CRDAs entered into under the specific authority of the 1986 act.

The agencies with the most CRDAs were Agriculture, NIH, and NIST. These agencies had entered into similar agreements with private industry prior to the 1986 act. Other agencies, such as the Air Force and the Army, which had not entered into similar agreements prior to the act, have begun entering into CRDAs. NASA has continued to enter into cooperative agreements under the Space Act.

The first agency to enter into a CRDA under the 1986 act was the Agriculture Research Service, which had already been working extensively to transfer technology to the private sector. In 1983, an Agriculture Research Service survey showed that its scientists had made over 61,000 industry and public contacts that fiscal year. Between 1980 and 1986, 28 inventions were patented for which exclusive licenses were granted to private sector entities. The Agriculture Research Service entered into its first CRDA under the authority of the 1986 act in July 1987 and had entered into 59 CRDAs as of February 1989.

Similarly, NIH and NIST had entered into a large number of CRDAs. NIH had been collaborating with companies prior to the act and had entered into 48 CRDAs under the authority of the 1986 act as of February 1989. Commerce's NIST and its predecessor, the National Bureau of Standards, have worked cooperatively with industry for about 60 years. NIST usually has about 1,100 cooperative agreements at any one time, but most of these agreements have not been made under the authority of the 1986 act and NIST does not consider them to be CRDAs. NIST defines CRDAs to be cooperative agreements that include preassigning titles or exclusive licensing rights to the collaborator. As of February 1989, NIST had entered into 37 CRDAs under the authority of the 1986 act.

Several agencies with no prior experience with collaborative agreements have also started to enter into CRDAs. For example, the Air Force entered into its first CRDA in September 1988. By February 1989, the Air Force had entered into eight CRDAs and was processing another nine. Similarly, the Army had entered into 12 CRDAs, and the Navy and EPA had entered into 1 each by February 1989. Table III.1 shows the number of all agencies' CRDAs as of February 1989.

Table III.1: Number of CRDAs, by Agency, as of February 1989

Agency	Number of CRDAs
Agricultural Research Service	59
NIST	37
NOAA	0[a]
Air Force	8
Army	12
Navy	1
Energy	0[b]
EPA	1
Bureau of Mines	1[c]
USGS	5[d]
NASA	0[e]
NIH	48
Total for selected agencies	172

[a] According to a NOAA official, NOAA is proceeding cautiously because it had not entered cooperative agreements with the private sector prior to the 1986 act. As of April 1989, NOAA was developing procedures for pursuing CRDAs and had one potential CRDA in process.

[b] Since 1986 the Department of Energy's energy technology centers have entered into 12 cooperative agreements, but these were not negotiated under the authority of the Federal Technology Transfer Act.

[c] The Bureau of Mines entered into about 180 other cooperative agreements under its authorizing legislation.

[d] USGS entered into about 900 other cooperative agreements under its authorizing legislation.

[e] From October 1986 to February 1989, NASA entered into about 108 agreements under the Space Act.

Source: Prepared by GAO from data provided by the agencies.

INCENTIVES TO FEDERAL EMPLOYEES

The Federal Technology Transfer Act of 1986 requires that agencies either distribute at least 15 percent of royalties and other income to federal inventors and others that assign rights to inventions to the federal government or establish an alternative royalty sharing program. The act also generally requires agencies to develop and implement cash award programs for technology transfer activities. Each of the 12 agencies we contacted either had distributed or planned to distribute to federal inventors at least 15 percent of the royalties collected. One agency had established a new cash awards program focused solely on technology transfer. Other agencies relied on their existing cash awards programs to reward their employees for promoting technology transfer. According to officials at the agencies and laboratories, agencies publicized their respective royalties and cash awards programs to their employees through various formal and informal mechanisms.

ROYALTIES COLLECTED AND DISTRIBUTED

As required by the 1986 act, each of the agencies we contacted had distributed or planned to distribute at least 15 percent of the royalties collected to the federal inventors. From the passage of the act in October 1986 through September 1988, the agencies we examined collected about $4.6 million in royalties.[1] Table IV.1 shows the amount of royalties collected from October 1986 through September 1988 by the agencies contacted.

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[1] Royalties collected include licensing fees and are not necessarily for agreements made under the authority of the 1986 act.

Table IV.1: Royalties Collected by Agencies, October 1986 to September 1988

Agency	Amount collected
Agricultural Research Service	$ 213,416
NIST	104,312
NOAA	11,492
Air Force	57,244
Army	28,535
Navy	20,048
Energy/Fossil Energy[a]	0
EPA	0
Bureau of Mines[b]	54,000
USGS	0
NASA[c]	181,760
NIH[c]	3,946,263
Total	$4,617,070

[a] The zero is for the Department of Energy's Office of Fossil Energy, which is responsible for the government-operated energy technology centers. Other entities within the Department of Energy collected royalties totaling about $881,000 for this period, but this amount was not subject to distribution under the 1986 act because the inventions were made by contractors.

[b] Bureau of Mines estimate.

[c] The amount shown for NASA is for the period October 1986 through December 1988.

[c] All of NIH's royalties were for agreements made prior to the 1986 act and were primarily for the National Cancer Institute's acquired immune deficiency syndrome-related inventions.

Source: Prepared by GAO from data provided by the agencies.

Table IV.2 shows the royalties distributed by percent from October 1986 through September 1988 by the agencies we contacted.

Table IV.2: Distribution of Royalties, October 1986 to September 1988

Agency	Percent distributed: Inventors	Offset expenses	Laboratories	Treasury
Agricultural Research Service	15	85	0	0
NIST	15	52	33	0
NOAA	15	85	0	0
Air Force[a]	0	0	0	0
Army[a]	0	0	0	0
Navy[b]	48	0	52	0
Energy/Fossil Energy[c]	0	0	0	0
EPA[d]	0	0	0	0
Bureau of Mines	15	35	50	0
USGS[e]	0	0	0	0
NASA[f]	65	0	24	11
NIH[g]	17	29	54	0

[a] The Air Force and the Army had not distributed any royalties collected as of February 1989. Each of these military services held the funds in an escrow account and planned to distribute to inventors the greater of the first $1,000 or 20 percent of the royalties collected annually for each invention.

[b] The Navy distributes to each inventor the greater of the first $1,000 or 20 percent of the royalties collected annually for each invention.

[c] The Department of Energy's Office of Fossil Energy had not collected any royalties during the period, but it planned to distribute to the inventors 15 percent of any future royalties collected.

[d] EPA had not collected any royalties during the period, but it had established a royalty program providing for inventors to receive about 35 percent of any future royalties collected.

[e] USGS had not collected any royalties during the period, but it planned to distribute to the inventors 15 percent of any future royalties collected.

[f] Percentages shown for NASA are for calendar years 1987-88. NASA provides its inventors the first $2,000 of royalties collected and 20 percent of the royalties in excess of the first $2,000. Remaining royalties are generally distributed to the field installations where the invention was made. However, if the amount to the field installation exceeds 5 percent of its budget, 25 percent of the excess is distributed to the field installations and 75 percent of the excess is paid to the Treasury.

[g] Fiscal year 1988 royalty data provided by NIH showed amounts distributed to inventors, but did not show other distributions. Percentages shown are for fiscal year 1987 distributions.

Source: Prepared by GAO from data provided by the agencies.

REWARDS FOR TECHNOLOGY TRANSFER

The Agriculture Research Service established a new cash awards program focused on technology transfer in September 1988 and plans to make the first cash awards in June 1989. Officials from other agencies pointed out that cash awards are given to inventors, as well as others, as part of their respective agencies' existing awards programs. Several agencies make cash awards to inventors when a patent is applied for and when it is granted. For example, inventors at NIH, the Air Force, and the Agricultural Research Service are awarded $100 when a patent is applied for and $300 when it is issued. Similarly, the Navy awards inventors $200 when a patent is applied for and $500 when it is issued.

PUBLICIZING INCENTIVE PROGRAMS

According to agency and laboratory officials, agencies publicize their respective royalties and cash awards programs to their employees through various formal and informal mechanisms. Royalty programs are publicized through written directives or memorandums, seminars, meetings, brochures, scientific meetings, agency or laboratory newspapers and newsletters, and informal discussions between supervisors and employees. The Agricultural Research Service has publicized its cash awards program in its Administrator's newsletter and a brochure.

DESCRIPTION OF OFFICES OF RESEARCH AND TECHNOLOGY APPLICATIONS

Under the Stevenson-Wydler Act, as amended, each federal laboratory must establish an ORTA.[1] To implement this requirement, the act requires each agency to determine, in consultation with its laboratories, (1) how the ORTAs should be staffed and funded and (2) whether to combine ORTA functions with any existing laboratory units that perform similar functions. If an agency has an established organizational structure outside its laboratories that has the principal purpose of technology transfer, the agency may elect to perform its ORTA functions in that organizational structure. Although this provision allows considerable flexibility, the act, as amended, requires that each laboratory having 200 or more full-time-equivalent scientific, engineering, and related technical positions staff its ORTA with one or more full-time-equivalent positions.

In general, the ORTAs' technology transfer functions are to (1) assess R&D projects with potential for successful application in the public or private sector; (2) provide and disseminate information on federally owned or originated products, processes, and services having potential applications; (3) provide technical assistance to state and local governments; (4) cooperate with organizations that link federal laboratories to potential users;

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[1] The general definition of a laboratory in the Stevenson-Wydler Act, as amended, is "any laboratory, any federally funded research and development center, or any [cooperative research center or National Science Foundation cooperative research center] that is owned, leased, or otherwise used by a federal agency and funded by the federal government, whether operated by the government or by a contractor."

and (5) participate in regional, state, and local programs designed to facilitate or stimulate technology transfer.

A description of the ORTAs is presented below by federal agency.

AGRICULTURE

Agricultural Research Service's implementation of the Federal Technology Transfer Act of 1986 is coordinated by its Office of Cooperative Interactions, headed by an Assistant Administrator. This office is staffed with 11 technical and 12 clerical personnel at various locations, including an ORTA in Beltsville, Maryland. This ORTA, staffed by a professional with marketing and extension service experience and a secretary, services the Beltsville Agricultural Research Center and the approximately 120 Agricultural Research Service field research facilities.

COMMERCE

National Institute of Standards and Technology

In NIST, the ORTA is part of the Director's office and is staffed by five professionals. The ORTA manages the agency's Research Associate Program, Small Business Innovation Research Program, and Inventions and Patent Committee. It also carries out the agency's assigned responsibilities to administratively support the FLC. The ORTA provides policy guidance, advice, and marketing support to managers and staff in identifying and acting upon cooperative research opportunities with industry and with state and local governments. It also represents NIST in the FLC.

National Oceanic and Atmospheric Administration

NOAA established an ORTA in its Office of the Chief Scientist, which has two full-time professionals and one secretary, and a part-time "ORTA contact" at each of its five major line organizations, who are responsible for ORTA functions in their respective laboratories. The ORTA and a representative from each major line organization make up the NOAA Technology Transfer Working Group, which coordinates the technology transfer activities.

NOAA ORTA officials have been active in the FLC, participating as members and serving on committees. Their activities include assessing transferable technologies, disseminating technical briefs (NOAA uses the National Technical Information Service to disseminate the information further), cooperating with other agencies, and providing direct contacts for queries from individuals and companies.

DEFENSE

Air Force

The Air Force responded that in establishing its ORTAs, as provided by the act it considered two major points: (1) its already existing technology transfer offices, called Science and Technical Information Program Management offices, substantially achieve the objective of transferring technology, and (2) its classified and national defense-oriented research and engineering efforts must be protected and are therefore inappropriate for transfer to the civil sector.

At the time the Stevenson-Wydler Act of 1980 was enacted, requiring ORTAs to be established, the Air Force already had Science and Technical Information Program Management offices in place. These offices are responsible for ensuring that scientific and technical information resulting from R&D are appropriately disseminated to potential contractors or users. The Air Force has such offices at all major commands, including the Air Force Systems Command. Within the Air Force Systems Command, the offices have been established at all divisions, centers, and laboratories.

In implementing the Stevenson-Wydler Act of 1980, according to the Air Force, it established ORTAs within this existing structure. At the laboratory we visited, Wright Aeronautical Laboratories, the ORTA is in the laboratory Director's program office, where ORTA-type functions are carried out by a full-time technical information specialist.

Army

At the time of passage of the 1986 act, the Army already had a regulation establishing a domestic technology transfer program (Army Regulation 70-57). This regulation, which was originally issued in 1976, was revised to implement the provisions of the original Stevenson-Wydler Act. The revised regulation provided for identifying laboratories that must have an ORTA, specified that the Army Material Command was responsible for coordinating laboratory programs Army-wide, and stated that all identified laboratories should participate in the FLC.

According to the Army, each of the 22 Army Material Command laboratories, including the two we visited, has an ORTA. The ORTA is often located organizationally within the technology planning, industrial liaison, or program management staff of the laboratory commander or director. In other cases, a group of related laboratories has less active points of contact coordinated by a more active manager at the subordinate command level. According to an Army official, no single organizational structure is suited to all laboratories. Almost half of the Army Material Command laboratories have active outreach programs in their region, state, and local areas.

The Corps of Engineers' Army Engineer Topographical Laboratories and the Army Medical Research and Development Command's Letterman Army Institute of Research, the two other Army laboratories we visited, had ORTAs performing various ORTA activities.

Navy

According to a Navy headquarters official, the Navy has full-time-equivalent ORTAs at each of its 14 laboratories with 200 or more scientific, engineering, and related technical positions. Four of the five Navy laboratories we visited told us they had ORTAs performing various ORTA activities. Officials at the fifth laboratory, the Navy Air Test Center, told us that the center does not have a designated ORTA, but has personnel who are responsible for technology transfer activities and spend a total of more than one full-time-equivalent position on such activities.

ENERGY

The Department of Energy's Office of Fossil Energy has ORTAs at its Morgantown Energy Technology Center, Pittsburgh Energy Technology Center, and Bartlesville Project Office. The ORTAs provide a central laboratory coordination point for technology transfer, help foster an environment that encourages researchers to consider potential technical applications, identify potential commercial applications, and make information available to stimulate technology transfer.

EPA

EPA's ORTA is in its Office of Research and Development, which has 14 laboratories that range in size from less than 50 persons to one laboratory with over 200 persons. Because of the relatively small size of EPA's laboratories, the Office of Research and Development combined them under one person at headquarters. This person is a member of the FLC and acts as the office's spokesman. To provide communication with the laboratories, a Technology Transfer Advisory Group was formed, comprising representatives of each laboratory and headquarters office.

According to EPA officials, the laboratory with over 200 persons, the Health Effects Research Laboratory, has a technology transfer coordinator with two staff. The coordinator reports to the laboratory director on technology transfer and other matters and, with the staff, expends more than a full-time-equivalent position on ORTA-type functions.

INTERIOR

Bureau of Mines

The Bureau of Mines' Office of Technology Transfer serves as the Bureau's ORTA. This office has a chief with a staff of seven, plus a technology transfer representative at each of the Bureau's nine research centers. Additionally, the Bureau has a special-emphasis Technology Transfer Office in Alaska, composed of three persons who report to the headquarters office. The Alaska office deals with specific minerals-related technology transfer within cold climates.

U.S. Geological Survey

USGS has an ORTA at its National Center in Reston, Virginia. In addition to conducting research at the National Center, the ORTA is responsible for regional centers located in Denver, Colorado, and Menlo Park, California, and for research and data gathering conducted at other USGS field offices located throughout the 50 states, Puerto Rico, and the Trust Territories of the Pacific. According to a USGS official, the regional centers are not laboratories but are responsible for the field offices in their respective regions. The regions do not have designated ORTAs, but according to the USGS official, they each expend far more than one full-time-equivalent position on technology transfer activities, such as conducting technical forums and seminars for industry and state and local government representatives. The Western region, located in Menlo Park, has a representative, reporting to the USGS Director, who performs many of the ORTA-type functions for the region. This representative is responsible for about 20 field offices, many of which have only one or two persons.

NASA

Because it conducts technology transfer activities as a coordinated program, NASA considers its entire system, headed by the Director, Technology Utilization Division, as its ORTA. The Director is located at headquarters and reports to the Assistant Administrator for Commercial Programs. Each NASA laboratory has a Technology Utilization Office, which is responsible for technology transfer activities at that laboratory. The organizational location of the Technology Utilization Offices varies among the laboratories at the discretion of the laboratory directors. The Technology Utilization Office at the NASA laboratory we visited, NASA Lewis Research Center, reports to the laboratory's Director, Office of Interagency and Industry Programs. This office conducts all of the activities typically performed by an ORTA, such as responding to inquiries from the private sector, other federal facilities, and state and local governments; promoting technology transfer to small businesses; and representing the laboratory on the FLC.

NIH

With the passage of the 1986 act, the ORTA and patent functions previously in NIH's Office of Medical Applications of Research were transferred to a new Office of Invention Development, which has four full-time positions. Additionally, each institute has a liaison who acts as a focal point for patenting and licensing activities. The Office of Invention Development provides staff support for the Patent Policy Board, attends FLC meetings, and conducts the NIH-industry forums that bring together NIH scientists and company or other outside representatives. The first forum was held in October 1988, with about 250 federal government scientists and 250 industry representatives attending. According to an NIH official, the initial forum was a success and forums will be held at least annually.

AGENCIES' AND LABORATORIES' VIEWS ON BARRIERS TO THE ACT'S IMPLEMENTATION

The barriers to the Federal Technology Transfer Act's implementation most frequently mentioned by the agencies and laboratories we contacted were: (1) federal computer software cannot be copyrighted, (2) companies need greater protection for proprietary information, (3) private industry finds required government procedures burdensome and time-consuming, and (4) conflicts of interest exist with agency missions and for government employees.[1]

COPYRIGHT OF COMPUTER SOFTWARE

While recent changes in the law allow federal laboratories to patent and exclusively license inventions, federal computer software cannot be copyrighted (17 U.S.C. 105). Without copyright protection, federal computer software is publicly available. Therefore, individual software companies have little incentive to develop the software further for commercial applications. For example, a software company may need to (1) debug and simplify the software to ensure that it works properly, (2) enhance it for different commercial applications, and (3) develop manuals and provide assistance to users. Some agency officials said that federal computer software should be treated as federal inventions, which can be patented and licensed.

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[1] The first three of these barriers are discussed in our report, Technology Transfer: Constraints Perceived by Federal Laboratory and Agency Officials (GAO/RCED-88-116BR, Mar. 4, 1988). Our report also discussed concerns about technology transfer constraints faced by the Department of Energy's contractor-operated laboratories. We do not address these concerns here because contractor-operated laboratories are not covered under the CRDA provisions of the Federal Technology Transfer Act.

Of the 25 laboratories in our study, 11 laboratories from 8 agencies responded that the absence of copyrights for federal computer software hindered their efforts to enter into CRDAs.

PROTECTION OF PROPRIETARY INFORMATION

Because federal laboratories generally cannot conduct proprietary research, industry is less inclined to collaborate with them. The results of unclassified and nonsensitive R&D at federal laboratories normally are published in the scientific literature and/or result in a patent application. Even if the results are not published, interested parties can, with certain exceptions, generally get information about federally funded research through a request under the Freedom of Information Act. That act requires federal agencies to make records promptly available to any person upon a request that reasonably describes such records and is made in accordance with published rules.

Officials from several laboratories and agencies advised us that the limited authority to conduct proprietary research was a constraint to technology transfer. Of the 25 laboratories in our study, 7 laboratories from 6 agencies responded that the status or clarity of rules and regulations protecting the confidentiality of data or processes developed through cooperative R&D had hurt their ability to enter into CRDAs; 8 laboratories from 7 agencies responded that public access to data via the Freedom of Information Act had hurt them.

BURDENSOME AND TIME-CONSUMING PROCEDURES

Federal laboratories, in their efforts to be fair in providing companies opportunities to collaborate on research, may institute burdensome and time-consuming procedures that inhibit industry participation. Officials at two agencies noted that because they had little interaction with private industry before the Federal Technology Transfer Act was enacted, the laboratories do not have procedures in place for determining the extent to which they will notify companies about potential collaborative research opportunities. These officials were concerned that after a CRDA had been entered into with a company, a competitor could claim, either legitimately or for the purpose of tying up the collaboration, that he was not offered a similar opportunity to collaborate.

Of the 25 laboratories in our study, 5 laboratories from 4 agencies responded that the rules and regulations on how cooperative R&D opportunities should be announced had hurt their efforts to enter into CRDAs.

CONFLICTS OF INTEREST

Some agencies mentioned concerns over two types of conflicts of interest: (1) collaborative work under CRDAs can create a conflict of interest with an agency's primary mission, and (2) financial interests in a collaborating company can cause a federal employee to have a conflict of interest. The U.S. Office of Government Ethics decided that royalty sharing, in itself, does not create a conflict of interest.

With respect to a conflict with an agency mission, a USGS official told us that the traditional USGS role of providing accurate and impartial information to the public could be compromised, or appear to be compromised, if USGS worked too closely with a particular industry. To illustrate, this official said that the Electric Power Research Institute proposed to collaborate on experiments on Eastern earthquakes. The results of the experiments might be used in siting decisions for a future nuclear power plant. If the Nuclear Regulatory Commission needed information on the likelihood of earthquakes at the nuclear power plant site, USGS' opinion might be perceived to have been compromised. Accordingly, USGS decided not to enter the proposed agreement.

Conflicts of interest also have been a concern at NIH, where some companies have been attempting to deal directly with federal inventors. In some instances, companies have contacted NIH inventors to negotiate special arrangements, such as foreign patent rights.[2] According to NIH officials, they are concerned that such contacts are being made while the government has the rights to file for foreign patents. NIH currently requires all scientists to report contacts with companies. This enables the National Technical Information Service, which handles NIH's licensing, to contact the companies and determine whether they are interested in a license and to recommend to NIH whether a foreign patent should be sought. NIH, in turn, can make a more informed decision on whether to file for foreign patents. NIH also is concerned because many of its scientists consult for private companies. Since August 1985, NIH has permitted its scientists to consult for companies on the basis of their general scientific knowledge and expertise. To protect against a conflict of interest, NIH staff are subject to various restrictions and safeguards, including a prohibition against receiving any payment from a company with which he or she has any official relationship, such as collaborating under a CRDA.

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[2] After 6 months of the filing for a U.S. patent or of the invention's disclosure, whichever is later, the right to file for foreign patents goes to the inventor.

In September 1988, the U.S. Office of Government Ethics advised the Commerce Department that royalty sharing under the Federal Technology Transfer Act does not give an employee a personal financial interest to which the conflict-of-interest laws are applicable. This decision resolves concerns that may have existed that royalty sharing by federal inventors in itself created a conflict of interest. However, it does not preclude conflicts of interest from occurring in situations such as those cited by USGS and NIH.

THE FEDERAL LABORATORY CONSORTIUM FOR TECHNOLOGY TRANSFER

FLC OBJECTIVES AND ACTIVITIES

The FLC evolved from a Department of Defense Laboratory Consortium established in 1971. Defense had created the consortium to improve interlaboratory communication and to find greater civilian uses for technical knowledge developed originally for military purposes. In 1974 the consortium adopted its current name and invited all federal agencies to participate. The Stevenson-Wydler Act of 1980 increased emphasis on technology transfer and stimulated the further growth of the FLC. The Technology Transfer Act of 1986 formally established the FLC and defined its roles and responsibilities, including

-- providing training assistance, advice, and assistance for individual transfer programs;

-- providing a clearinghouse for technology user requests;

-- facilitating interagency and laboratory communication and coordination;

-- assisting individual laboratories in developing technical transfer mechanisms; and

-- facilitating communication and cooperation with public and private technology transfer organizations and user groups.

More than 300 federal laboratories and research centers, representing 14 federal agencies, are presently members of the FLC.

Each of the agencies we examined participate in the FLC's activities.

VIEWS ON THE FLC

Most of the agency and laboratory officials responded that their laboratories benefited from the FLC's activities. For example, NOAA officials commented that the FLC is a "super" group and has done an exceptional job and that the FLC's current emphasis on clearinghouse and outreach efforts to match interested companies with researchers in federal laboratories is appropriate. The activity cited most frequently as being beneficial to the laboratories was the FLC's workshops and seminars. The only concern mentioned by those supporting the FLC was that different interpretations of what an agency is required to contribute have resulted in some agencies not paying their full share. Suggestions by laboratory officials for improving the FLC related primarily to increasing its funding or the number of employees.

Officials from two agencies thought the FLC to be of general value, but did not believe the clearinghouse and outreach efforts provided benefits to their laboratories. According to an NIH official, the FLC is of general value in matching companies with agencies and laboratories. However, this official explained that the FLC would need a massive organization to match companies with specific researchers and this function is better left in the agencies, which can design specific systems to meet their individual needs. The official pointed out that NIH developed its industrial collaboration forum to meet this need. Similarly, an Agriculture official told us that, in his view, the FLC's attempts to match companies with laboratory researchers can be done better closer to the researchers.

According to an Air Force headquarters official, the Air Force receives little benefit from the FLC. On the other hand, an official at the Air Force Wright Aeronautical Laboratories, who has actively participated in the FLC, believed the FLC provided benefits to the laboratory.

FLC FUNDING

To fund the FLC's activities, the 1986 act required agencies to transfer 0.005 percent of their federal laboratories' R&D budgets to the FLC.[1] This percentage was increased to 0.008 percent by the Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418). According to NIST, which collects the funds for the FLC, agencies meeting the $10,000 threshold have contributed funds for the FLC as shown in table VII.1.

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[1] The Federal Technology Transfer Act of 1986 required agencies to transfer funds to the FLC in fiscal years 1987 through 1991. However, the act further stipulated that an agency need not transfer funds to the FLC if the amounts to be transferred totaled $10,000 or less.

Table VII.1: Agency Contributions to the FLC, Fiscal Years 1987 and 1988

Dollars in Thousands

	FY 1987	FY 1988
Agriculture	$ 25.0[a]	$ 25.5
Commerce	12.1	13.1
Army	94.5	126.1
Navy	157.0	166.3
Air Force	13.6	14.3
Energy	218.0[a]	227.0
NIH	33.0[a]	35.2
Interior	0[a]	16.6
NASA	80.0	77.5
Total	$633.2	$701.6

[a] Fiscal year 1987 was the first funding for the FLC under the act, and the former National Bureau of Standards billed only selected agencies. The agencies indicated were not billed, but some provided funds.

Source: NIST.

According to a NIST official, agencies have been very responsive in making their FLC contributions, with the exception of the Air Force. In fiscal years 1987 and 1988, the Air Force paid significantly less than what NIST billed. NIST bills agencies by applying the percent set forth in the law to each agency's intramural budget as reported by the National Science Foundation.[2] Table VII.2 shows the amounts NIST billed and the amounts the Air Force paid for fiscal years 1987-88.

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[2] As part of its report Federal Funds for Research and Development, the National Science Foundation reports each federal agency's intramural budget. The foundation defines intramural work as that carried out directly by federal agency personnel.

Table VII.2: Air Force FLC Contributions

Dollars in Thousands

Fiscal year	Amount billed	Amount received	Percent of amount billed
1987	$174.6	$ 13.6	7.8
1988	186.5	14.3	7.7

Source: NIST.

For fiscal year 1989, the Congress reworded the provision governing the FLC funding transfers with an amendment in the Omnibus Trade and Competitiveness Act of 1988. The provision (section 11(e)(7)(A) of the Stevenson-Wydler act, as amended) states, in part, the following:

> ". . . An amount equal to 0.008 percent of the budget of each Federal agency from any Federal source, including related overhead, that is to be utilized by or on behalf of the laboratories of such agency for a fiscal year . . . shall be transferred . . . for the purpose of carrying out activities of the Consortium . . . ."

The Air Force initially disagreed with the amount NIST computed as the Air Force's share for fiscal year 1989 and computed a smaller amount based on the in-house portion of its laboratories' R&D budgets. After we pointed out to Air Force officials that the amount for the FLC should be based on the Air Force laboratories' total R&D budget, the Air Force recomputed the amount it will transfer for fiscal year 1989. In April 1989, NIST and the Air Force agreed on the amount the Air Force will pay for fiscal year 1989--$123,900.

INCENTIVES FOR SEEKING FOREIGN PATENT PROTECTION

According to National Technical Information Service (NTIS) and Patent and Trademark Office officials,[1] the incentive to domestic users for seeking foreign patent protection is the expected profits. Domestic users of federal inventions may file for foreign patent protection if they have title to the invention. If title to the invention is retained by the government, the decision on whether to file is the government's or, in some cases, the federal inventor's. If exclusive licensing is preassigned through a CRDA, the government retains the patent filing rights but consults with the participating company in deciding whether to file for foreign patent protection.

AUTHORITY TO FILE

The government usually owns a federal invention and the right to file for foreign patents. However, if the government does not file for a foreign patent within 6 months of the filing for a U.S. patent, the declassification of a previously classified invention, or the invention's disclosure, whichever is later, the right to file for foreign patents goes to the inventor.[2] In such cases, where practical, the government would retain a nonexclusive, irrevocable royalty-free license in any foreign patent issued. The inventor may file for the foreign patent(s), sell the right to file to the private sector, or assign the right back to the government.

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[1] NTIS files for foreign patents on behalf of most of the agencies we studied. The Patent and Trademark Office is involved in receiving and processing applications for foreign patents.

[2] The 6-month period is established by 37 C.F.R. 101.

In most foreign countries, filing must be done within 1 year of the U.S. patent application filing date.

Under the Federal Technology Transfer Act of 1986, agencies and/or laboratories may preassign to companies participating in CRDAs the title or exclusive licensing rights to federal inventions. When title is preassigned to a company, the government retains a royalty-free nonexclusive license to use the invention, but the invention resulting from the cooperative research is owned by the company. In such cases, the company may seek foreign patent protection as it deems appropriate. When an exclusive license is preassigned, the government retains ownership of federal inventions, and the participating company has the right of first refusal to an exclusive license. In these cases, the government has the right to file for foreign patents, but agencies usually consult with the prospective licensees and pass on the patent filing costs to the eventual licensees.

According to an NTIS official, most agencies entering into CRDAs have chosen to retain title to federal inventions and grant exclusive licenses. This official said that agencies generally follow the licensees' decisions on whether to file for a foreign patent, but retaining ownership puts the agencies in a better position to influence the development of the technology. If a technology is not properly used, agencies can step in and exercise prerogatives to further develop the technology. Another factor in agencies' choosing to preassign exclusive licenses instead of titles is that greater recognition is given to the federal inventor and the agency when the patent is filed by the government.

SEEKING FOREIGN PATENT PROTECTION

According to NTIS and Patent and Trademark Office officials, deciding whether to file for foreign patents is a "business decision" depending on the expected profitability of an invention in foreign markets. A Patent Office official explained that whether sufficient incentive exists to seek foreign patent protection is a function of the expected profitability. If a potential market appears profitable, a company will presumably seek to protect that market with a patent.

NTIS files for foreign patents and negotiates the licensing terms on behalf of most of the federal agencies we studied. According to NTIS officials, in deciding whether or not to file for foreign patents in the past, NTIS often considered the longer-range objective of protecting the government and the U.S. economy against foreign competitors. Although NTIS still considers this long-range objective, it now places greater emphasis on the shorter-term payoff. NTIS gets agreement with an agency before it files. These officials could not recall an agency's refusing to file for a foreign patent because of costs. In negotiating the terms of CRDAs, agencies usually include exclusive licensing clauses to the collaborating company. In these cases, the agencies consult with the licensees on whether to file for a foreign patent and usually follow the desire of the licensees. The clauses include a requirement for the licensee to pay fixed fees for initial filing and annual patent maintenance costs. Licensees must also agree to provide a royalty as a percentage of sales.

Although they did not believe additional incentives were needed, NTIS and Patent Office officials advised us of some barriers to foreign patent protection. According to NTIS officials, the biggest barrier to foreign patent protection has been the 6-month time frame in which the federal government must decide whether it wants to file for foreign patent protection. After 6 months, the inventor has the right to file on his or her own, or to sell that right to the private sector. Frequently, about 2 months have elapsed by the time NTIS receives the invention from the federal agency where the invention was made. Therefore, NTIS has only a 4-month window in which to decide. Sometimes the decision on whether to file must be made before a licensee is found. On occasion the inventor has given the right to file back to the government, and the time frame has been extended to the full year in which filing must be done. The 6-month filing period, established by Commerce's regulations in 1952, is currently under review by Commerce's Chief General Counsel.

According to a Patent Office official, cost is one constraint to domestic users (not just of federal inventions) seeking foreign patent protection. The cost of foreign patent protection in most Western industrial markets (Western Europe, Japan, Australia, and Canada) would amount to about $40,000, compared with the basic fee of $900 in the United States ($340 application fee and $560 issue fee).[3] In addition, since a patent attorney costs about $100 to $200 per hour, legal charges could amount to $2,000 or more. The United States charges maintenance fees after 3-1/2 years ($450), 7-1/2 years ($890), and 11-1/2 years ($1,340). The total maintenance charge over the 17-year life of a U.S. patent is $2,680. The fees charged to nonprofit organizations, small businesses, and universities are reduced by one-half. Since a patent is more expensive to maintain the longer it is in force, a Patent Office official pointed out that a company is more likely to let it lapse after some years. According to the Patent Office official, foreign countries have different maintenance charges; for example, the United Kingdom has annual taxes starting 3 years after the application is submitted, and France has an annual tax each year after the submissions. Some countries have flat taxes, and others have progressive taxes that increase each year.

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[3] The Patent and Trademark Office adjusted its patent fee amounts, increasing the basic filing fee to $370 and the issue fee to $620, effective April 17, 1989. Maintenance fees were increased to $490 at 3-1/2 years, $980 at 7-1/2 years, and $1,480 at 11-1/2 years.

According to a Patent Office official, U.S. companies may be making a decision "by default." That is, rather than spending money on patent attorneys, U.S. companies might be choosing not to seek foreign patents, which have various requirements that are different from those in the United States. For example, the United States and the Philippines are the only countries to grant patents on a first-to-invent basis. Elsewhere, patents are granted on a first-to-file basis. Commerce has an effort to "harmonize" the worldwide patent requirements through the World Intellectual Property Organization and trilateral cooperative meetings of the United States, Japanese, and European patent offices. Other countries, particularly Japan, would like to see the United States change to the first-to-file basis. This harmonization effort is still in progress. Consequently, the Patent and Trademark Office does not want to move prematurely or seek legislation at this point that might jeopardize the negotiations. When the time is appropriate, a Patent and Trademark Office official told us that the Patent Office will probably propose legislation through appropriate channels.

Officials interviewed from other agencies were generally unfamiliar with the details of foreign patents. A NIST official said that his agency leaves the decision about seeking a foreign patent up to the companies and NTIS. This official said that the decision is a business one and that companies are "pretty smart" about what to apply for. A patent attorney from NASA, which obtains its own patents and licenses, similarly told us that while the costs of foreign patents are high, the judgment about whether to obtain one is a business decision.

DEVELOPMENT OF TECHNOLOGY TRANSFER REPORTING CRITERIA

In a September 1988 letter, the House Committee on Science, Space, and Technology asked us to develop criteria for reporting on technology transfer activities. The Committee made this separate request to help resolve reporting problems that we uncovered during the early phases of our review of the implementation of the Federal Technology Transfer Act of 1986. Currently, federal agencies that operate or direct one or more federal laboratories are required by the 1986 act to report on their activities implementing the act's technology transfer provisions. For the past 2 fiscal years, agencies have submitted these reports to the Office of Management and Budget.

Problems surfaced in the interpretation of the data contained in these reports largely for two reasons: (1) some officials responsible for responding to the Office of Management and Budget's request for information on technology transfer activities found that the terms used in the request are ambiguous, and (2) reporting instructions regarding exactly what data to include in agencies' calculations have not been made clear. For example, some officials responsible for preparing these reports were uncertain about what technology transfer activities to include when calculating funds devoted to technology transfer or estimating the value of CRDAs. An Office of Management and Budget official indicated that the agency did not expect good or complete data from the first year's reports and that it would take at least 2 years for the data to stabilize. However, reporting problems are not likely to disappear unless an effort is made to dispel ambiguities in the guidance for report preparation.

In April 1988, the Congress requested the agencies and selected laboratories to provide detailed information on the steps they had taken to implement the technology transfer legislation.[1] As with the reports to the Office of Management and Budget, the written responses of the agencies and laboratories proved, overall, to be difficult to interpret.

To respond to the Committee's request for criteria for laboratory reporting, it was necessary to develop comparable, valid, reliable, and reportable measures of the impact of recent legislation on laboratory technology transfer activities. Therefore, we reviewed technology transfer literature and analyzed the major technology transfer legislation since 1980.[2] We also analyzed the responses prepared by departments and laboratories to the set of questions from the Congress, and fiscal year 1989 Office of Management and Budget reports. In addition, we conducted interviews with department or agency technology transfer officials.[3]

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[1] This information was requested by the Chairman, Senate Committee on Commerce, Science, and Transportation and the Chairman, House Subcommittee on Science, Research, and Technology.

[2] Specifically, we analyzed the Stevenson-Wydler Technology Innovation Act of 1980 (P.L. 96-480); the Federal Technology Transfer Act of 1986 (P.L. 99-502); Executive Order 12591, "Facilitating Access to Science and Technology"; the Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418); the Bayh-Dole Act (P.L. 96-517); and various conference reports associated with legislation.

After analyzing the data collected in the activities discussed above and accounting as much as possible for differences across laboratories, we structured the criteria as a questionnaire for laboratory directors. The questionnaire was submitted for comment to approximately 70 reviewers outside GAO, including department, agency, and laboratory technology transfer officials and university technology transfer experts. It was then further modified on the basis of comments received from reviewers and pretested during April and May 1989 to develop additional information necessary to ready the questionnaire for implementation.[4]

The questionnaire we have developed has several characteristics. First, it includes precise definitions of terms that may affect the type of data reported. These definitions should allow department and laboratory officials to provide valid, reliable, and comparable data. Second, it is divided into two parts: a 5-section laboratory-level questionnaire, targeted to respondents in various laboratory units, and an agency-level questionnaire, to be answered by agencies or departments. In this way, we should obtain the information needed from the respondents best able to provide it. Third, it includes questions not asked by the Office of Management and Budget or Commerce for their reports, but that help develop a more complete picture of the impact of legislation on technology transfer activities. As such, it should produce more comprehensive information than has been available to date.

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[3] We interviewed officials at the following Departments: Agriculture (specifically the Agricultural Research Service), Defense, the Army, the Air Force, the Navy, Transportation, Interior (specifically the Bureau of Mines and USGS), Commerce, Energy, Veteran's Affairs, and Health and Human Services (specifically NIH); and at EPA and NASA. We also interviewed officials at the Office of Management and Budget, the National Science Foundation, and the FLC. We interviewed these officials to obtain their views and suggestions for developing criteria and to determine what information they need on technology transfer activities.

[4] As agreed to with the Committee, the questionnaire is expected to be implemented at the beginning of the next fiscal year to enable collection of complete fiscal year 1989 data.

The GAO-developed questionnaire is designed to provide comprehensive and uniform data to (1) aid congressional oversight of laboratory and department technology transfer activities and programs and (2) enhance the ability of departments and laboratories to manage and evaluate their technology transfer programs.

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Mr. **Walgren**. Thank you very much. We appreciate your—your having developed that survey for us and I hope that it will give us an opportunity to pursue the individual agencies that—and their practices—in hopes of encouraging them to move in this area.

Let me ask whether your instinct is that things have changed at all? Do you have any instinct on that? Is there a judgment that you can make on the overall of whether technology transfer has been moved forward by this effort?

Mr. **Ols**. I think the consensus among our team that did the work—we believe that we see the technology transfer activities rising. I think some agencies, as I mentioned, started a little slower or a little cautious, but I think the momentum is really picking up speed. I think that is a positive sign for the agencies.

Many of the agreements were entered into just recently this spring, and several are on the negotiating table, if you will, to enter into more agreements. So I think that is a very positive sign.

Mr. **Walgren**. This is something that we have been pursuing for something in the range of 10 years. There is this requirement that each agency at each laboratory have an Office of Research and Technology Applications, a little formalistic, as I understand it, because an office can perhaps be a name only, but is the structure there? Do you find that office in each of the laboratories as has been intended by the legislation?

Mr. **Ols**. I'll let Mr. Mininger answer. He talked to a lot of the officials out in all the individual laboratories.

Mr. **Mininger**. Generally, there—actually, there—they don't always call the organization an ORTA, but the law does, again, permit some flexibility there. If there is an equivalent staff person at an organizational level that is performing technology transfer type activities and that always—we found those do exist. They don't, again, have ORTAs as such, but they meet the definition of—the requirement of having technology people at the location that are performing the function. So, yes, they are meeting it in that sense.

And generally, we're finding that the people seem to be very capable and enthusiastic about the program. In some cases, they feel like there's some limitations. There is not always good regulations procedures yet available to give them good guidance, but they certainly are trying to promote tech transfer. At least that is what we found in visiting around.

Mr. **Walgren**. The—we have you pursuing this questionnaire that hopefully will at least give us assurance that each proper level has focused on the problem and at least given it their attention, and you indicated that each agency has filed the reports that they were required to under the act.

I had been under a different impression, that some of the annual reports that had been required by the act had not been submitted.

Mr. **Ols**. I don't—from our knowledge and from our looking at it, we don't have any record that none have filed that I know of.

Mr. **Mininger**. The reports—of course, the Commerce report we mentioned, that's not yet available, but that is in draft and in final form apparently in Commerce.

The budget information that was submitted to OMB was again difficult to deal with and it went to OMB, rather than the Congress, so that made it—and we found all that information was not really usable because of the form it was in.

Mr. OLS. But I think—we don't have any record of reports not being submitted, Mr. Chairman.

Mr. WALGREN. Perhaps you can think about and give us a submission on the usableness of this information that we might ask in the form of a questionnaire. Admittedly, falling back on a questionnaire shows that we are limited in our own ability to drive this.

One of the things that I think would strike us all is that—that this is a hard area to succeed in. If it were easy to succeed in it, there'd be an awful lot of success out there and in many ways, it's like a small business or starting up a small business. If it were an easy thing to do, a lot of other people would be much more successful than—than we are.

But it's a hard thing to do and somehow or other, the—the measure that we make has to take into account how difficult it is and give some recognition to efforts and the quality efforts regardless of how many dollars may pass through the cash register or the like and I would hope that you would look at this information that's in OMB and, with the thought of what—you know, what are we asking on these questionnaires and if you could make as creative a suggestion as you can about the content of that questionnaire so that we can them focused and receive back a good measure of the kind of effort that is being made, recognizing that it is a difficult area to succeed in.

Mr. OLS. Okay, yes, Mr. Chairman, we'll be glad to.

Mr. WALGREN. The Chair would recognize the gentleman from Colorado, Mr. Skaggs.

Mr. SKAGGS. Good morning, Mr. Chairman.

I apologize for not being here for your prepared statement, or at least not very much of it, so if I cover some of the things you've already covered, forgive me.

I'm curious as to the process that you used in selecting the agencies and laboratories that were talked to for this study.

Mr. ARIMA. We picked large labs in the Washington area that were of particular interest to the staff and we're also asked to go—

Mr. SKAGGS. Our staff or your staff?

Mr. ARIMA. By congressional staff.

Mr. SKAGGS. Okay.

Mr. ARIMA. And we also picked the region outside of the Washington area just to get some labs that were further away from headquarters.

Mr. SKAGGS. I'm particularly interested in that the Solar Energy Research Institute, which is nearby my part of Colorado and is probably one of the facilities that we hope will be doing the most to move things from laboratory to production purposes, was not included and I am wondering if you, nonetheless, have any information pertaining to how SERI is doing in this area?

Mr. ARIMA. No, we limited ourselves to government-operated laboratories; SERI is contractor-operated.

Mr. SKAGGS. And what was the rationale for that limitation?

Mr. ARIMA. Under the provisions, that's limited to government-operated laboratories.

Mr. OLS. And being that our primary focus was on how those were working, that's why we concentrated on—

Mr. SKAGGS. Okay—

Mr. OLS. —the government-operated, yes.

Mr. SKAGGS. I'm encouraged by your testimony that you're finding that the officers principally responsible for technology transfer matters seem enthusiastic and committed and all the rest.

I guess my brief experience in this field is—or suggests that what is going to be necessary for us to do better is for there to be a technology transfer culture instilled pervasively throughout the research organizations. How do you see that progressing?

Mr. MININGER. I think in response to the chairman's question, I see that starting to gain momentum and I think that's through talking—you don't need to have a fixed structure to make that work and I see the talking going that we're having more and more technology transfer ideas. We're thinking; we're looking that way to create a better competitiveness from the country itself.

Positively, I see that moving forward that way.

Mr. SKAGGS. Are there any particular examples or models that you came across that were being particularly successful in getting that culture established throughout an organization?

Mr. MININGER. I think, again, the—some of the agencies and the laboratories that have been in this business for quite a while are certainly good models. NIH is doing a very good job. So is Agriculture.

Mr. SKAGGS. But what is it about their operations that could be transferable—the transfer of technology transfer, if you will?

Mr. MININGER. I think it—I think it relates to the working relationships that they're establishing with industry and that takes some time to prove out successfully. And I think a very important part of changing that culture is certainly convincing industry that there're a lot of good things in the labs to take advantage of.

I think as industry begins to see that both big business and small business people begin to see the opportunities there and see that there are research areas and a lot of good technology that can be transferred and commercialized effectively, I think—I think it's going to start taking hold a lot better, but again, the agencies that are doing the better job with that are ones that have had more experience with that in the past.

I think it is a cultural type of change that is necessary and I think, like the Federal Lab Consortium and other groups that are really trying to promote this idea, I think—I think they are having some success, but again, it's a slow process that involves both outreach efforts and initiatives by the lab people, the agency-level people, as well as industry people that begin to catch on to see that this really has some possibilities.

Mr. OLS. I probably would add to that, I think the one point you might look at is their ability to reach out and try to tap and get people interested in sharing things. I think that's really the one point that—maybe that gets them a step ahead. They go out and talk at meetings and discuss these things a little bit, maybe, more fully than some other agencies might do.

I think that would be one of the big reasons, plus the momentum that's going that way.

Mr. SKAGGS. When we had the National Science Foundation—I believe it was—witnesses here some weeks back, the idea was discussed that perhaps we should be explicitly funding research into technology transfer as a way of becoming more sophisticated about the techniques, about developing models, about finding out what the ingredients are, being contemplative in an organized fashion about this problem.

Do you, from your experience, think that would be a good and appropriate use of actual research dollars?

Mr. OLS. I probably would say I really don't have a basis to, you know, to give you an answer. I think that's an approach that could be used, but I think—I think things are moving to make it work that way, so I'm not so sure we have to make it quite that drastic a step of funding just strictly research. I mean, at least that would be my opinion, and I'm only speaking from my own views.

Mr. SKAGGS. I guess I don't see it as drastic, but really, you know, a logical additional tactic to use that we're sort of going out there in a charge-ahead, let's-take-the-hill kind of approach, rather than perhaps also giving some people the resources to examine it in a theoretical way as well.

Ms. WALFORD. If I may add to that—

Mr. SKAGGS. You need to switch on your mike. There you go.

Ms. WALFORD. If I may add to that, during the process of developing the questionnaire that we're planning to implement to capture some information on the inputs into the tech transfer process, during that process, we had the questionnaire reviewed by a number of people, approximately 70 people, including department officials, agency officials and academics who have some experience in the technology transfer area, and many of the people who commented brought up this issue of how do you go about measuring the outcomes of technology transfer, how can we identify what models are actually working, and I'd say that there was a fairly strong emphasis placed on trying to develop some kind of information so that in the future, we will know what works and what doesn't work.

So, in response to your question, I would say that, at least from those who reviewed our questionnaire, there is some support for that.

Mr. SKAGGS. Thank you, Mr. Chairman.

Mr. WALGREN. Thank you, Mr. Skaggs.

The gentlelady from Rhode Island, Ms. Schneider.

Ms. SCHNEIDER. Thank you. Thank you, Mr. Chairman.

Despite the fact that I just got word that I have to leave this hearing, I regret it because, to me, this is one of the most important issues that we, as a nation, need to deal with, and I happen to believe that the more we can increase the speed with which we do not only technology transfer, but we do information transfer, the better off we will be.

I happen to co-chair the Competitiveness Caucus and constantly I am besieged with questions from the private sector saying, "Do we really need to spend money any more on our national laboratories? Are they not perhaps outmoded or outdated?"

Your comment a short while ago was that, you know, different businesses and industries are looking to see how they can take advantage of the resources there. I think it is incumbent upon we, as the government, to get that information out as quickly as possible.

I'm not convinced that we have the appropriate infrastructure for that information and technology transfer, but I do feel the urgency of it. And I hope that you can call on me as an individual or on this Committee so that we can speed this process along, because I feel we're at a point now of crisis management, as opposed to taking preventive measures or just moving along at an important clip.

I think we are in a very critical stage right now for getting the information out as quickly as possible.

Mr. Chairman, I have no further questions, but—for this panel, but I would like to ask permission to have my questions submitted for the record for the—panel number three.

Mr. WALGREN. Without objection, we'll cover that. [See Appendix].

Ms. SCHNEIDER. Thank you. Thank you for your good work.

Mr. WALGREN. —at that point.

Mr. OLS. Thank you.

Ms. SCHNEIDER. We appreciate it.

Mr. WALGREN. The—it seems to make sense to take some measure of where we are. We're spending $60 billion in research and development per year, and the total licensing royalties collected by all agencies is running about what per year?

Mr. OLS. I think in total, we had, what, $4.9—.6 million were collected and—

Mr. WALGREN. Over a two-year period.

Mr. OLS. Yeah, over that '86 to '88, and I think one of the problems, or one of the difficulties with that is some inventions—it takes roughly two to three years to reach the marketplace before you start getting return on—

Mr. WALGREN. But I'm just thinking of the overall. We've been spending something in the range of $60 billion for 25, 30 years, I gather, in the Federal Government's R&D effort, and I just wanted to make the point that compared to the expenditure, there really does not seem to be any significant recognition of the value of that, at least in terms of licensing royalties presently flowing to the Federal system.

Mr. OLS. And I would agree, looking at it that way.

Mr. WALGREN. And of the approximately $2 million a year, over $1.5 million of that appears to be in the National Institutes of Health, so the whole rest of this Federal Government, in which we're spending $60 billion in ways that should lead to some interesting and applicable technology, at least to a certain amount of it, that $60 billion is presently resulting in—in $1.5 million in—no, $500,000, aside from NIH, $500,000 in revenue back to the government.

I guess I say that to make the point, are we essentially starting at ground zero, from your opinion, in terms of the transfer of technology to the private sector?

Mr. OLS. I think that's true. I think the other agencies, as I said, are at zero and are moving forward now and it's going to take a little while. And that's why we—we don't feel we can evaluate the total impact because that's one of the indicators you would use, until we have a little bit more time under this and have some consistent information.

Mr. **Walgren**. Well, we look forward to your helping us gather that consistent information—

Mr. **Ols**. All right, thank you, Mr. Chairman.

Mr. **Walgren**. —so we can measure this area.

Thank you very much.

Let me call the second panel. Dr. Loren Schmid, the Chairman of the Federal Laboratory Consortium; and also on that panel, we've asked Dr. L. H. Princen, the Director of the Northern Regional Research Center at the U.S. Department of Agriculture to join us; Richard Stern, in his capacity as Technology Transfer and Small Business Manager of the Electronics Technology and Devices Laboratory, from Ft. Monmouth; also Dr. Grant Brewen, the President of Biotechnology Research and Development Corporation, from Peoria, Illinois; and Dr. Reid Adler, the Director of the Office of Implementation Development at the National Institutes of Health.

Gentlemen, we appreciate your—your being here and talking with us about your experiences in this area. Your written statements will be made part of the record without more and—let me see exactly how much time we have. I'd like to ask if you can put in the back of your mind as you give your presentation, if you can keep it somewhere in the range of seven or so minutes because we have a very special ceremony, as you all know, at 11:45 this morning in honor of Senator Pepper, who passed away this last week.

And I'd like to be able to get all the testimony in before then so as not to totally inconvenience the later witnesses.

So, with that, let me invite you, Dr. Schmid, to proceed.

STATEMENTS OF LOREN SCHMID, CHAIRMAN, FEDERAL LABORATORY CONSORTIUM FOR TECHNOLOGY TRANSFER AND PROGRAM MANAGER, PACIFIC NORTHWEST LABORATORY, RICHLAND, WASHINGTON; L. H. PRINCEN, DIRECTOR, NORTHERN REGIONAL RESEARCH CENTER, USDA/ARS, PEORIA, ILLINOIS; RICHARD STERN, TECHNOLOGY TRANSFER/SMALL BUSINESS MANAGER, ELECTRONICS TECHNOLOGY & DEVICES LABORATORY, FT. MONMOUTH, NEW JERSEY; J. GRANT BREWEN, PRESIDENT, BIOTECHNOLOGY R&D CORPORATION, PEORIA, ILLINOIS; AND REID ADLER, DIRECTOR, OFFICE OF INVENTION DEVELOPMENT, NATIONAL INSTITUTES OF HEALTH, BETHESDA, MARYLAND

Dr. **Schmid**. Okay.

Mr. Chairman, and Members of the Subcommittee, I appreciate this opportunity to present views on technology transfer on behalf of the Federal Laboratory Consortium.

Today, as requested, I am reporting on Consortium activities and successes since the Federal Technology Transfer Act of 1986.

I'll only be able to cover highlights, but additional information is found in my written remarks and in the Consortium Annual Reports to Congress. A review copy of the latest annual report is available as part of my written statement.

The Federal Laboratory Consortium's mission is to promote the rapid movement of research results from the Federal laboratories into use in the private and public sectors. We accomplish that mission through a coordinated program directed at meeting the technology transfer needs of our member laboratories and the needs of the potential users of their technologies.

In addition to creating a technology transfer environment, which adds value to and supports our members laboratory and agency efforts, our programs also focus on national efforts that are beyond the scope of individual laboratories or agencies.

As you know, the Consortium was formally chartered by the Technology Transfer Act of 1986, and I am pleased to report that all Consortium programs identified in that act are operational and effective. Considering the initiatives under way with small business, large business, educational institutions and State and local governments, the diverse and disaggregated nature of the small business community poses a unique challenge in developing national initiatives.

However, we have been gaining insights from demonstrations such as those with VoTech in Oklahoma and NASA's Application Center in California. These insights are proving important as we plan to replicate the experiences in other States and regions.

In all of our initiatives, the key factor for successful transfers are person-to-person contact or cooperation, supported by ongoing institutional cooperation. Transfers work best when there is a continuum of cooperation which begins at the idea stage and continues through engineering development to an ultimate use.

The universities, Federal laboratories and industry all have a part in the process and it requires innovations and cooperation at all stages. A significant part of the Consortium effort is to facilitate that cooperation.

Our resources for facilitating cooperation are, first, a decentralized network of representatives operating as a clearinghouse for matching laboratory expertise to technical requests; a clearinghouse locator for laboratory capabilities and expertise; a computerized 168-laboratory resource directory that is used to match request or needs with laboratory expertise and an electronic mail system of 89 representatives and advisors for rapid and efficient communications during the matching process and to meet other Consortium operating requirements.

While the clearinghouse function emphasizes the matching of requests for technical assistance with laboratory expertise and capabilities, other resources and referrals are used for requests for information and technologies available.

These resources include the National Technical Information Service, NASA's Application Centers, and commercial data bases. An important data base of technologies is provided by the Technology Applications Information System of the Strategic Defense Initiative Organization. Accessing that data base provides the user with more than 1000 unclassified abstracts describing SDI-developed technologies and their potential applications to public and private sectors.

An FLC coordinator for each one of six regions is a primary referral point in the clearinghouse network for technical requests; is an organizer of special regional projects; and is an awareness focal point for the laboratories and user organizations in that region.

With the support of NASA, our Southeast Region has established an FLC Service Center to assist in handling regional requests for technical assistance. This regional satellite is an important adjunct for effectively operating the FLC network to accomplish our clearinghouse function.

In fact, I wish the Consortium had similar service centers in the other five regions.

Regional advisors, funding for regional programs and administrative support to the Regional Coordinators are part of an emphasis that has strengthened the Consortium significantly.

Although the legislation is clear on a matter of Cooperative Research and Development Agreements, the lack of rules and regulations left some in a quandary as how to proceed to implement the legislation. Others saw it as an opportunity to proceed and develop procedures that met their specific needs.

The Consortium infrastructure has been used for training in this important area and to allow others to learn from the experiences of those who have proceeded. The legislation has been instrumental in furthering technology transfer cooperation. Extension of the Cooperative R&D Agreement authority to include explicitly Government-Owned Contractor-Operated facilities, as well as Federal Contract Research Centers, would broaden the value of this mechanism to the U.S.

The Northern Agriculture Research Center in Illinois illustrates the major results possible with the change in public policy. This center, with approximately 150 professional staff, have licensed several major patents and established a significant biotechnology R&D consortium that contributes to the local economy.

Another small organization, the Army Electronics Technology and Devices Laboratory have been very proactive in establishing several Cooperative R&D Agreements. In the past, they have benefited by networking with the FLC and now they are feeding back their experiences to the network.

Also, they are leading the way by including quantitative measures related to technology transfer in their staff performance reviews.

With its national focus, the Federal Laboratory Consortium provides an excellent platform for member laboratories to address broad subject areas of national significance. For example, the opportunities under the anti-drug abuse bill and responsibilities under the Omnibus Trade and Competitiveness Act. Other initiatives focus on user needs for topics such as hazardous materials management, biotechnology and utility technologies.

For example, an agreement was signed with the Electric Power Research Institute to cooperate in transferring Federal technologies from member laboratories to their member utilities. This agreement, and one with the Center for the New West, is expected to be the basis for a broader utilities initiative later on.

One unique demonstration in this country is the technology ferret program, modeled after a British effort. The demonstration is planned at the Naval Underwater Systems Center for this year. An industry retiree will work with laboratory staff to ferret out previously unrecognized technologies and expertise of value to industry. Assuming a successful demonstration, plans are to replicate this program at other laboratories.

In conclusion, during the two years since the passage of the Federal Technology Transfer Act of 1986, the Consortium network has been strengthened. All FLC programs identified by the act are operational and effective. Emphasis has been on providing opportunities for person-to-person cooperation, strengthening regional operations and increasing training opportunities for member representatives.

Major accomplishments include significant initiatives with small business, large industry, State and local governments and universities and other educational institutions; an operating infrastructure that effectively supports interlaboratory cooperation, rapid communications and technology transfer recognition; growing programs in the six FLC geographical regions combined with regional advisors to keep the Consortium on target in its transfer efforts; training programs which include topics such as patents, licensing, Cooperative Research and Development Agreements and marketing of laboratory technologies; a fully operational clearinghouse that is a resource for matching requests for technical assistance with Federal laboratory capabilities and expertise; cooperation with other networks with similar interests, such as professional societies, trade associations, small business groups and utilities; and completion of a model demonstration project that provides laboratory access to technology acquisition interests of over 1000 companies and initiation of a new project with the U.S. Conference of Mayors.

During this time, I have noticed an increased awareness of the importance of technology transfer on the part of the laboratories, the agencies, and the potential users of innovations. Some of this awareness is occurring because of past successes that are being documented, experiences that are being shared, and the recognition that laboratory missions and commercial opportunities are compatible.

This growing awareness and continuing progress makes me optimistic that technology-based cooperation will provide increasing benefits to the U.S. economy and that the Consortium will provide a basic link between the user and government collaborators.

Thank you for this opportunity to give me—to give you my impressions.

[The prepared statement of Dr. Schmid follows:]

LOREN C. SCHMID Chairman, Federal Laboratory Consortium for Technology Transfer and Program Manager, Pacific Northwest Laboratory

Dr. Schmid has B.A., M.S, and Ph.D degrees in Physics from the University of Michigan. He is a member of the New York Academy of Science, and the Sigma Xi scientific honorary society and is an elected Fellow of the American Nuclear Society. He received the FLC Harold Metcalf Award for Technology Transfer in 1986 for continuous, dedicated service to the consortium and its programs, and his successful efforts to improve the technology transfer process.

Dr. Schmid is the Chairman of the Federal Laboratory Consortium (FLC) for Technology Transfer and manages the development of new ideas for Pacific Northwest Laboratory's (managed by Battelle-Northwest) engineering technology business, supports the Office of Technology Research and Applications, and serves as a member of the Battelle-Northwest Safety Review Council. He is an affiliate professor of Nuclear Engineering for the University of Washington; a post he has filled since 1973. In addition to lecturing and advising students and faculty, he has developed and implemented educational courses in fission reactor experiments, direct energy conversion, and magnetic fusion. He is also an advisor to the Strategic Defense Initiative Office of Technology Applications. Previous to being elected Chairman, he was elected Regional Coordinator for the FLC Far West Region and served on the Executive and various standing committees.

Statement of
Loren C. Schmid
Chairman of the Federal Laboratory Consortium for Technology Transfer
before the
Science, Research & Technology Subcommittee
House Committee on Science, Space & Technology
June 1, 1989

Mr. Chairman and Members of the Subcommittee:

I appreciate this opportunity to present some views on technology transfer on behalf of the Federal Laboratory Consortium (FLC). Today as requested, I plan to report on Consortium activities and successes, since the Federal Technology Transfer Act of 1986, as well as provide an overview of some recent member laboratory successes. Details about successes at two laboratories will be presented by other speakers on this panel. Additional information is found in the Consortium annual reports to Congress and our member Federal Agencies. A review copy of the latest annual report is available as part of my written statement.

As stated in our Strategic Plan, the Federal Laboratory Consortium's mission is to promote the rapid movement of research results from the federal laboratories into use in the private and public sectors. We accomplish that mission through a coordinated program directed at meeting the technology transfer needs of our member laboratories and the needs of the potential users of their technologies. We focus on creating a technology transfer environment which adds value to and supports our member laboratory and agency efforts. The support is provided primarily through laboratory infrastructure development, technology transfer promotion, and national communication and coordination. Promotion of technology transfer to government and industry as a major national resource is an important effort.

In addition to support to our member laboratories, our programs focus on national efforts that are beyond the scope of individual laboratories or agencies. Another focus with nationwide impact involves monitoring the success of individual laboratory initiatives and facilitating their rapid replication.

The Consortium was formally chartered by the Federal Technology Transfer Act of 1986. However, it has been in existence in one form or another for 18 years. Thus, the Consortium was able to hit the track running relative to the activities mandated by the legislation. The programs are to include activities such as providing advice and assistance on technology transfer methodology, facilitating communication between the technology transfer officers at the laboratories, and preparing training courses and materials related to technology transfer. Other programs include strengthening our regional activities, conducting demonstration experiments with potential for replication, and providing a clearinghouse network for technical assistance requests at the laboratory level.

I am pleased to report that all Consortium programs identified by the Federal Technology Transfer Act of 1986 are operational and effective.

Significant Initiatives

Small Business: The importance of small- and medium-sized businesses to the nation's competitive position and job creation is well understood. The diverse and disaggregated nature of the small business community poses a unique challenge in developing national initiatives. One small business initiative has focused on working with state-level programs, participating in government innovation workshops, and replicating the successful experience of individual laboratories.

Linkages are being developed that provide opportunities to interact with state groups serving small businesses and to obtain their assistance in linking with the small business. Recently, a program was run in Oklahoma which provided important insights for future efforts. The Consortium combined resources with the State Department of Vocational Technical Education to create an environment where laboratory and small business staff could interact in technology areas of mutual interest. The insights are proving important as we plan to replicate the experience in other states; e.g. Washington, California, and New York.

While the Consortium had experience and mechanisms to network with large businesses at FLC meetings and workshops, many of the small business interactions were on a local level by individual laboratories and interactions with individual businesses through a combination of the Affiliates Program of NASA's Industrial Application Center in California and the Consortium network. The combination allows small businesses to contact technical information sources and laboratory technical assistance through the small business development centers in 15 states. Other interactions included support for establishing incubators, business opportunity programs, and Small Business Innovation Research Program relationships.

Large Business: Larger companies have resources and wide interests that can facilitate a broad range of long term relationships with Federal laboratories. The Consortium's strategy for developing this initiative is to reach individual companies and their trade associations directly at both executive and technical levels. Under this strategy, effective technology transfer workshops with large companies have continued regularly. In addition, special workshops are focusing on needs identified by the companies for specific business sectors.

Other networking occurred in the manufacturing technology area through national conferences. One with IRI focused on computer-integrated manufacturing technologies of the Army, Navy, Air Force, National Institute of Standards and Technology, the National Aeronautics and Space Administration, and the Department of Energy. Another with the National Center for Manufacturing Sciences focused on gaining a strategic advantage through manufacturing research cooperation, coordination, and communications. The latter group, established under the Cooperative R&D Act and operating out of Michigan, is a consortium of approximately 80 small, medium, and large manufacturing businesses. The organization's goal is to enhance the international competitiveness of U.S. manufacturing by funding research on advanced manufacturing technologies and transferring results to members.

Businesses with prominent manufacturing components are very sensitive to the need for technological education so their workers can understand and implement technology changes.

Educational Institutions: Several models have been developed for cooperation with educational entities in their research, education, and community service functions. In one, a workshop brought university, Federal laboratory and economic development representatives together for a vigorous and productive exchange on the roles of centers of excellence in economic development. In another, university expertise will be included as a resource to meet technical requests. For several years, member laboratory activities to enhance math and science education at the pre-college level have been growing. These activities, while not part of the technology transfer programs, are nevertheless important for future transfer efforts. Therefore the Consortium has encouraged the strengthening and replicating of those programs.

State and Local Government Programs: State and local governments are responsible for a significant portion of the services provided to citizens; and they are direct users of laboratory technology. The Local Government Information network is using the Consortium network as a resource for its clients. A formal arrangement with the Building Research Board of the National Academy of Sciences has made laboratory construction expertise available to state and local governments. For example, a voice-activated system for inspecting documentation was transferred to the state of New York at an estimated savings of $1M per year. In another example, Philadelphia park officials have benefited from technical assistance and the loan of equipment from the U.S. Forest Service. Training for and replication of technical volunteer services in 9-10 local communities by the Consortium several years ago continue to provide benefits. Because of a renewed interest in other localities, the Consortium is evaluating the need for reestablishing the program.

Developing Person-to-Person Cooperation

A key factor for successful transfers are person-to-person contact or cooperation, supported by ongoing institutional cooperation. It is difficult to explicitly define technology transfer so that it includes all of the activities that are part of the transfer process. Research and development cannot be simply assessed and technologies available for transfer identified and handed from one organization to another. Transfers work best when there is a continuum of cooperation which begins at the idea stage and continues through engineering development to an ultimate use. A common ground for this cooperation is economic development. The universities, Federal laboratories, and industry all have a part in the process, and it requires innovations and cooperation at all stages. Therefore a significant part of the Consortium effort is to facilitate that cooperation.

Clearinghouse: A dispersed FLC network is operating effectively as a clearinghouse for matching laboratory expertise to technical requests. A Clearinghouse locator for laboratory capabilities and expertise supports the network and is operating out of an office in California. This function has strengthened our ability to develop person-to-person interactions and cooperation. The Clearinghouse serves the Consortium Representatives and Regional Coordinators as they receive requests at the laboratory or regional level and directly by a call from a requester. A significant capability of the clearinghouse is a computerized 168-laboratory resource directory that is used to match requestor needs with laboratory expertise. An electronic mail system serves a network of 89 representatives and advisors for rapid and efficient communications during the matching process and to meet other operating requirements.

The Clearinghouse has emphasized the matching of requests for technical assistance with laboratory expertise and capabilities. Other resources and referrals are used for information requests such as technologies available. These resources include the National Technical Information Service, NASA's Application Centers, and commercial databases. An important database of technologies is provided by the Technology Applications Information System of the Strategic Defense Initiative Organization, a Consortium member. Accessing that database provides the user with more than 1000 unclassified abstracts describing SDI-developed technologies and their potential applications to public and private sector ventures.

Transfer Mechanisms: Technology transfer requires all forms of personal and institutional cooperation. Transfer mechanisms used by the laboratories include workshops and briefings, laboratory visits, personnel exchanges, technical assistance, cooperative research, and licensing. A document "Putting Technology to Work" compiled by the Consortium has been in great demand by persons interested in interacting with the Federal laboratories. It provides examples of the availability and value of laboratory technology transfer. The document describes 138 examples, from 31 laboratories, of various mechanisms that have been successful for transferring their technologies. More success stories are included in the Appendix of the review copy of the FLC annual report in the list of FLC Technology Transfer Excellence Awards. Other examples related to local governments are found in "Tapping Federal Laboratories and Universities to Improve Local Economies: The Role of the Mayor and City Government" issued by the United States Conference of Mayors. These examples are useful for letting others know the types of cooperation that are possible through interactions with the federal laboratories. The Consortium continues to compile these successes and recent illustrative examples are available upon request.

Regional Emphasis

Regional Operations: The operational arm of the Consortium includes six Regions; Northeast, Southeast, Mid-Atlantic, Midwest, Midcontinent, and Far West. A coordinator for each region is a primary referral point in the clearinghouse network for technical requests, an organizer of special regional projects, and an awareness focal point for the laboratories and user organizations in their region.

Regional advisors, funding for regional programs, and administrative support to the Regional Coordinators are part of a regional emphasis that has strengthened the Consortium significantly. All six regions of the Consortium have Regional Advisors. In addition, the National Advisors membership configuration has been modified to include one member from each of the six regions and six at-large members. Operational funds have been provided to those regions to support their operations and to develop programs that encourage interactions between the laboratories in the region and with user groups. The FLC Administrator staff provide support to each of the Regional Coordinators in accomplishing their regional activities.

Technical Requests: An important function of the Regional Offices is an entry point for networking technical assistance requests. With the support of NASA, the Southeast Region has established an FLC Service Center at the Stennis Space Center in Mississippi to assist in handling regional requests for technical assistance. This regional satellite is an important adjunct for effectively operating the FLC network to accomplish our clearinghouse function. I wish that the Consortium had similar service centers in the other five regions.

Model Projects: As required by the Federal Technology Transfer Act of 1986, model demonstration projects have been awarded to nonprofit organizations. The first project has been completed and resulted in a database of technology seekers and technology acquisition interests and basic information for licensing agreements. The database contains information for over 1000 companies that laboratories can use to match their technologies with the technology seeker's interest. The second model demonstration has been awarded. The Conference of Mayors was the successful proposer and will work with selected cities and Federal laboratories to encourage partnerships between the cities and the laboratories and the use of Federal technology and expertise in municipal services and to foster economic development.

Training

Legislative changes and practical experience are increasing the demand for targeted training for individuals assigned to technology transfer. In response to requests from our member laboratory representatives, we have increased the technology transfer training opportunities at the National Meetings. Training sessions have included patents and licensing from the industry and laboratory perspective, marketing of laboratory technologies, militarily critical technology issues, and cooperative research and development agreements. Our new representative training sessions have been modified to included more advanced training.

Organizational Collaboration and Cooperation

The Cooperative R&D Act eases the antitrust concerns of companies wishing to pool research resources, and the Technology Transfer Act and the April 1987 Executive Order allow the director of a government-operated laboratory to enter into cooperative research and development agreements. Although the latter is clear on the matter of Cooperative research and Development Agreements, the lack of rules and regulations left some in a quandary as to how to proceed to implement the Act. Others saw it as an opportunity to proceed and developed procedures that met their specific needs.

The Consortium infrastructure has been used for training in this important area and to allow others to learn from the experiences of those who have proceeded. Both of these Acts have been instrumental in furthering technology transfer cooperation. Extension of the Cooperative R&D Agreement authority to include explicitly Government-Owned Contractor-operated facilities, as well as Federal Contract Research Centers, would broaden the value of this mechanism to the U.S.

The Northern Agricultural Research Center in Illinois illustrates the major results possible with only a change in public policy. This center, with only approximately 150 professional staff, has licensed several major patents and has established a Biotechnology R&D Consortium that contributes to the local economy.

Another small organization, the Army Electronics Technology and Devices Laboratory has been very proactive in establishing several Cooperative R&D Agreements. Numerous agreements are in process. In the past, they have gained information by networking with the FLC and now they are feeding back their experiences to the network. They have included quantitative measures related to technology transfer in their staff review procedures.

The National Institute of Standards and Technology also has experienced a surge in new agreements. Fifty have been completed over the last fourteen months.

Consortium Technology Transfer Excellence Awards were presented to staff of the Army Construction Engineering Research Laboratory and the Air Force Geophysical Laboratory for being the first in their service organizations to establish Cooperative R&D Agreements based on software technology.

New Initiatives

National: With its national focus, the Federal Laboratory Consortium provides an excellent platform for member laboratories to address broad subject areas of national significance. The preparation of a directory of superconductivity activities developed in 1987 for a special meeting requested by the President was such an effort. Current legislation such as the Omnibus Trade and Competitiveness Act and the Anti-Drug Abuse Bill provide new opportunities.

For example, close interaction with the National Institute of Standards and Technology after the enactment of the Omnibus Trade and Competitiveness Act has led to early program planning and a detailed draft agreement for formal cooperation under their Technology Extension Service responsibility. We anticipate joint efforts in workshops and seminars, training in use of available resources, and state demonstration programs.

User Needs: Other initiatives focus on user needs for topics such as hazardous materials management and biotechnology. Working with the Industrial Research Institute, we are planning a hazardous materials workshop based on the technology requirements of the aerospace and electronics industries. The Institute has identified processes and materials where federal technology could potentially mitigate hazardous material management problems. The idea for this approach and the need were identified by the FLC Far West Advisors and a national conference is being planned for Los Angeles, California, in the fall. It is expected that this conference will serve as a prototype for replication to other sectors of U.S. industry.

A member laboratory, the National Center for Toxicological Research, will take the lead in convening a Federal laboratory/industry conference to explore biotechnology problems or needs and technical expertise available to meet the needs. The objective is to identify and promote opportunities for industry-laboratory collaboration in this strategically important field.

A technology ferret program demonstration, modelled after a British effort, is planned for this year. The demonstration will be at the Naval Underwater Systems Center. An industry retiree will work with laboratory staff to ferret out previously unrecognized technologies and expertise of value to industry. Assuming a successful demonstration, the program will be replicated at other laboratories.

User Networks: Cooperation with other networks with similar interests such as professional societies, trade associations, utilities, and small business groups is a good way to leverage the resources of both networks. In cooperation with the Strategic Defense Initiative Organization and the Los Alamos National Laboratory, the Consortium held a workshop with professional societies and trade organizations to develop methods to encourage the members of their organizations to work with Federal laboratories. A symposium on technology transfer and Federal laboratories was prepared for the Small Chemical Businesses Division and presented at the National Meeting of the American Chemical Society. Other interactions include the American Society of Mechanical Engineers, the Aerospace Industries Association, the American Defense Preparedness Association, and the National Society of Professional Engineers.

An agreement was signed with the Electric Power Research Institute (EPRI) to cooperate in transferring Federal technologies to their member utilities. The EPRI will establish a center to provide the special focus on government developed technologies. Center staff will identify high impact needs and prioritize laboratory technologies which have potential for meeting those needs. To meet its responsibilities in identifying the laboratory expertise and capabilities, the FLC will use its existing network of contacts and laboratory representatives and the technology transfer experience of its member laboratories. This agreement and one with the Center for the New West is expected to be the basis for a broader utilities initiative.

A Vision of the Future World of Technology Transfer

My optimistic view of the future of technology transfer is a world where science and technology will be put to work effectively because there is:

(1) An abundance of precompetitive collaboration; that is collaboration with the Federal laboratories, universities, and industry at a stage in the evolution of the technology before potential users take the information to the marketplace in a competitive way;

(2) Short-term and long-term relationships between laboratories, businesses, and educational entities related to technology development, understanding, and application;

(3) Significant numbers of technical staff in laboratories on assignment to and from industry and universities; in addition, there are significant numbers of other assignment combinations occurring;

(4) Strong cooperation at both the technical and management levels in the participating organizations; and

(5) Cooperative research, development, and innovation focusing on the strategic view of future uses, with a healthy acceptance of risk by all.

Conclusions

During the two years since the passage of the Federal Technology Transfer Act of 1986, the Consortium network that supports cooperation among the Federal laboratories and with potential public and private sector collaborators has been strengthened. All FLC programs identified by the Act are operational and effective. Emphasis has been on providing opportunities for person-to-person cooperation, strengthening the regional operations, and increasing training opportunities for member representatives.

Major accomplishments include

- Significant initiatives with small business, large industry, State and local governments, and universities and other educational institutions;
- An operating infrastructure that effectively supports interlaboratory cooperation, rapid communications, and technology transfer recognition;
- Growing programs in the six FLC geographical regions combined with regional advisors to keep the Consortium on target in its transfer efforts;
- Training programs which include topics such as patents, licensing, Cooperative Research and Development Agreements, and marketing of laboratory technologies;
- Fully operational Clearinghouse that is a primary resource for matching requests for technical assistance with Federal laboratory capabilities and expertise;
- Cooperation with other networks with similar interests such as professional societies, trade associations, small business groups, and utilities; and
- Completion of a model demonstration project that provides laboratory access to technology acquisition interests of over 1000 companies and initiation of a new project with the U.S. Conference of Mayors.

I have noticed an increased awareness of the importance of technology transfer on the part of the laboratories, the agencies, and potential users of innovations. Some of this awareness is occurring because of past successes that are being documented, experiences that are being shared, and the recognition that laboratory missions and commercial opportunities are compatible.

This growing awareness and continuing progress makes me optimistic that technology-based cooperation will provide increasing benefits to the U.S. economy and that the Consortium will provide a basic link between the user and government collaborators.

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REPORT TO THE CONGRESS
AND
THE FEDERAL AGENCIES

Activities and Accomplishments of the Federal Laboratory Consortium for Technology Transfer Pursuant to the Federal Technology Transfer Act of 1986

Report submitted by:

Dr. Loren C. Schmid
Chairman

6-89

EXECUTIVE SUMMARY

The purpose of technology transfer is to strengthen the nation's economy by enhancing the application of Federal laboratory technology and expertise to the needs and opportunities provided by U.S. businesses, universities, State and local governments, and Federal agencies. Technology transfer works best when there is a continuum of cooperation which begins at the idea or research stage and continues through engineering development to an ultimate use. It is difficult to explicitly define technology transfer so that it includes all of the activities that are part of the transfer process. However, successful transfers ultimately result in product and process improvements, increased service efficiencies, cooperative efforts which address government and private sector needs, and new products and processes for the marketplace.

The Federal Laboratory Consortium for Technology Transfer was formally chartered by the Federal Technology Transfer Act of 1986. However, it has been in existence in one form or another for 18 years. Our mission is to promote the rapid movement of Federal laboratory research results and technologies into the mainstream of the U.S. economy. We accomplish this mission through a coordinated program which supports the technology transfer needs of our member laboratories and agencies and the users of their technologies.

During the past year, the network which supports cooperation among the Federal laboratories and with potential users of their technologies has been strengthened and all FLC programs identified by the Federal Technology Transfer Act of 1986 are operational and effective. Emphasis has been on providing opportunities for person-to-person cooperation, strengthening the regional operations, and increasing training opportunities for member representatives.

Major accomplishments include:

- Significant initiatives at various levels of development with small business, large industry, State and local governments, and universities and other educational entities;
- An operating infrastructure that effectively supports interlaboratory cooperation, rapid communication, and technology transfer recognition;

- Growing programs in the six FLC geographical regions combined with regional advisors to keep the Consortium on target in its transfer efforts;
- Training programs which include topics such as patents, licensing, and Cooperative Research and Development Agreements;
- Fully operational Clearinghouse that is a primary resource for matching requests for technical assistance with Federal laboratory capabilities and expertise;
- Initiation of efforts in support of national initiatives such as hazardous materials management, biotechnology, and the Omnibus Trade and Competitiveness Act of 1988;
- Cooperating with other networks with similar interests such as professional societies, trade associations, small business groups, and utilities; and
- Completion of a model demonstration project that provides laboratory access to technology acquisition interests of over 1000 companies and initiation of a new project with the U.S. Conference of Mayors.

The Consortium has noticed an increased awareness of the importance of technology transfer on the part of the laboratories, the agencies, and the potential users of innovations. Some of this increased awareness is occurring because of past successes that are being documented, experiences that are being shared, and the recognition that laboratory missions and commercial opportunities are compatible.

This growing awareness and continuing progress generates optimism that such technology - based cooperation provides increasing benefits to the U.S. economy and that the FLC will provide a basic link between the user and the government collaborator.

Much of the Consortium vision and progress is due to the dedicated efforts of the FLC leadership, committee members, Advisory Groups and the Agency Liaison Group listed in the Appendix. Special recognition is due the Past Chairman, Dr. Eugene Stark, Jr., who was instrumental in the preparation of this report. His dedication during the 1980's served us well as the Federal laboratories, their agencies, and the Consortium addressed the opportunities of technology transfer

Reported by:

Dr. Loren C. Schmid, Chairman
Federal Laboratory Consortium

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NATIONAL INITIATIVES WITH THE PRIVATE AND PUBLIC SECTORS

The Federal Laboratory Consortium (FLC) received its legislative mandate under the Technology Transfer Act of 1986 (PL99-50) to facilitate Federal technology transfer in cooperation with Federal laboratories and the private sector. To achieve this the FLC initiates national programs that are beyond the scope of individual laboratories or agencies. In most of these initiatives, the Consortium represents the broad resources necessary for substantial progress. Another approach with nationwide impact involves monitoring the success of individual laboratory initiatives and facilitating their rapid replication.

INDUSTRY

The larger companies have ample resources and wide interests that can facilitate a broad range of long-term relationships with the Federal laboratories. The Consortium's strategy for developing this opportunity is to approach individual companies and their trade associations directly at both executive and technical levels.

In cooperation with the Industrial Research Institute (IRI) a concept to link American industry with the government's manufacturing technology programs was developed. The result was a national conference in March, 1988, cosponsored by the Consortium and the IRI, hosted by the Wright Research and Development Center. The conference focused on computer-integrated manufacturing, with presentations by representatives of the three military services, the National Bureau of Standards, (now National Institute of Standards and Technology), the National Aeronautics and Space Administration and the Department of Energy. There were representatives from State and local based programs, academe and more than fifty American companies in attendance. They overwhelmingly rated this conference extremely valuable in forging relationships with the government technology programs. They also indicated a strong interest in similarly-focused initiatives in other areas of manufacturing technology.

The FLC continued its cooperation with a nonprofit organization, Technology Transfer Conferences, Inc. in organizing working sessions between Federal laboratories and companies in the areas of physical and life sciences. Since 1982, the FLC has sponsored a series of nine intensive Technology Transfer Conferences designed to spark industrial interactions with participating Federal laboratories. At the 1988 meeting, 17 laboratories described their most promising technologies to representatives of 28 major companies. Another session is scheduled in 1989 in Philadelphia.

Substantial progress in developing laboratory - industry cooperation has been made through interaction with the Industrial Research Institute (IRI). Current approaches used by the Consortium were confirmed by a survey of 200 industry research directors and technical managers. In addition to reinforcing the current approach of FLC member laboratories the resulting information will influence the planning of future programs. The survey results were the basis of a Special Interest Session of the IRI's October, 1988 conference. Their assessment of the key factors for success were:

Person-to-Person Contact
Existence of a Transfer Champion
Establishment of Proprietary Rights
Middle-Management Support
Flexibility of Approach

A majority of the responses reported satisfactory experience with the laboratories and were quite positive about the promise of future benefits to their companies resulting from this cooperation and interaction. Their preferred modes of interaction were:

Individual Laboratory visits
Information Dissemination
Cooperative Research

Other methods mentioned by a significant number of respondents were:

Workshops/Seminars
Technical Consultation
Contract Research
Use of Laboratory Facilities

Less favored, but mentioned by approximately 20% of the respondents:

Licensing
Employee Exchange
Sponsored Research

During 1988, the Consortium worked with the Electric Power Research Institute (EPRI) to develop an agreement, signed in 1989, to cooperate in technology transfer to the nuclear power industry. Under this memorandum of understanding EPRI will establish a Nuclear Technology Transfer Center to provide the special focus on government developed technologies. The center staff will identify high impact needs and prioritize laboratory technologies which have potential for meeting those needs. To meet its responsibilities, the FLC will use its knowledge of Federal laboratory expertise and technologies, its existing network of contacts and laboratory representatives, and the experience of its laboratories in moving technologies from the laboratory to the user. EPRI has identified a total of 20 key technologies and 12 are classed as high priority. A preliminary matching of the needs with laboratory expertise has identified 89 laboratories that potentially could provide input for meeting these needs. Many of these laboratories have not worked with EPRI before.

Beginning with its Fall 1988 meeting, the Consortium has organized plenary sessions at which industry representatives can describe their companies' areas of interest. High level representatives of 3M, Hewlett-Packard, Borg-Warner Chemicals and Allied Signal participated in this first session, which is now a permanent feature of the Consortium's semi-annual meetings.

Planning began in 1988 for a major industry - Federal laboratory workshop on hazardous materials technology for the aerospace and electronics industries, as described later in this report under Special Initiatives.

SMALL BUSINESS

The importance of small business to the nation's competitive position and job creation is well understood. The diverse and disaggregated nature of the small business community poses a unique challenge in developing national initiatives. Our approach has focused on working with state-level programs, participating in government innovation workshops, and replicating the successful experience of individual laboratories.

The Consortium's Small Business Subcommittee undertook a major demonstration program with the Oklahoma Department of Vocational and Technical Education (VoTech) to link Federal laboratories with small business. The staffs of 41 VoTech centers were trained in the use of the FLC and other resources for small business and a transfer workshop was held in October involving representatives from 13 laboratories and the Oklahoma private and public sectors. As a direct result of this initiative, a follow-up workshop on flexible manufacturing was held in April, 1989, and a state-level consortium for technology transfer is in the formation stage. This consortium will include VoTech, the Oklahoma Center for the Advancement of Science and Technology, Rural

Enterprises, Inc., the State Small Business Development Center, and the engineering colleges of the University of Oklahoma and the University of Tulsa.

Based on the Oklahoma experience, initiatives will be made in another 6-12 states to enhance development of state-scale expertise in technology transfer as a resource for business enhancement and economic development. The first follow-on project will be with Fresno City College (FCC), in the Central Valley of California. This project will begin with a training session to which the remaining 106 California community colleges will be invited.

The Consortium continues to promote cooperation with SBIR award winning companies by assisting individual laboratories' outreach to these firms and by participating in national SBIR conferences with exhibits and presentations.

A project was begun in 1988 to strengthen the process of entrepreneurial spin-offs from the laboratories. A set of spin-offs is being studied to provide both documentation and a training package on the success factors, problem resolution, and institution of properly supportive laboratory policy.

The Consortium continues its cooperation with the NASA Applications Centers to provide laboratory linkages to appropriate small-business clients.

STATE AND LOCAL GOVERNMENT PROGRAMS

State and local governments are responsible for a significant portion of the services provided to citizens; and they have been direct users of laboratory technology. In many instances, these governments have effective programs to assist resident companies, to which Federal laboratory technology contributes. Nonprofit, geographically-based programs are also important in technology transfer. In planning for passage of the technology portion of the Omnibus Trade and Competitiveness Act of 1988, the Consortium maintained close communication with the National Bureau of Standards (now NIST) to develop close cooperation in its new Technology Extension Service responsibility; details on this cooperation are provided later in this report. The newest Model Demonstration program, described under that report section, involves the U.S. Conference of Mayors (USCM) and will provide an excellent basis for renewed activity in the local government arena. The project with USCM will couple nine cities with nine or more Federal laboratories to use new technologies for specific urban needs. The project has a high potential for replication and will very likely reveal innovative models which can be broadly applied. The FLC is participating in the selection of cities to be included in this project.

The FLC Southeast Region developed a continuing relationship with the Southern Growth Policies Board to work on economic development and education improvement.

The Local Government Information Network, LOGIN, approached the Consortium to use the FLC Clearinghouse as a resource for its clients. This interaction is now underway.

The New York Science and Technology Foundation has placed representatives at the Rome Air Development Center and the Brookhaven National Laboratory to provide working links to New York companies.

UNIVERSITIES - THE EDUCATION SYSTEM - AND TRAINING

The Consortium is developing several models for cooperation with education entities in their research, education and community service functions.

The FLC Southeast Region and the FLC University Relations Subcommittee held a workshop on the role of university centers of excellence in economic development in early 1989. The Chairman of the FLC University Relations Subcommittee developed and chaired the conference. It was sponsored by the FLC, Southern Growth Policies Board, and the Oak Ridge Associated Universities - DOE. The sessions brought university, Federal laboratory and economic development representatives together for a vigorous and productive exchange. A steering group will carry forward with subsequent centers of excellence workshops on focused technology areas. These will continue to receive planning and participatory input from the FLC.

The results of a survey of university technical expertise have been put into the keyword format of the FLC's Resource Directory. Expansion and an update of this information are planned as a resource for the FLC Clearinghouse.

The FLC made contact with the American Society for Engineering Education, which has a program to train the engineering faculty of top universities in the newest technologies, thereby transferring them into the undergraduate curriculum. The first involvement of a

Federal laboratory will occur in 1989, when a program on manufacturing technology will be held at NIST.

For several years, laboratory activities to enhance American education at all levels have been growing. In 1988, the FLC began to focus some effort on strengthening and replicating these programs, and to encourage "demand pull" by the education community.

Information on present laboratory activities was assembled for a presentation to an educational technology conference of the Council of Chief State School Officers. This information will be documented for use and consideration for possible replication by other laboratories.

SPECIAL INITIATIVES

With its national focus the FLC provides an excellent platform for member laboratories to address broad subject areas. The directory of superconductivity activities developed in 1987 was such an effort. Current national initiatives such as the Omnibus Trade and Competitiveness Act and the Anti-Drug Abuse Act provide new opportunities. Current examples of some special initiatives are:

Hazardous Materials Workshop - A workshop on Hazardous Materials Management, will be held October 11-12, 1989. Laboratory presentations and a roundtable format will be used to present specific laboratory technologies. A survey of involved companies has identified major processing, operational and material concerns to be addressed. This conference will serve as a prototype for analogous programs with other sectors of U.S. industry to solve problems of mitigating or eliminating use of hazardous materials and production of hazardous wastes.

Biotechnology - A member laboratory, the National Center for Toxicological Research will convene a Federal laboratory-industry conference to explore these organizations' expertise and ongoing problems in biotechnology; the objective is to identify and promote opportunities for industry-laboratory collaboration in this strategically important field.

Industrial Research Exposition - The FLC Industry/Government/University Resources Chairman will lead a plenary session entitled "The Federal Laboratories: A National Resource for Technology and Innovation." Successful transfer case histories and process "How to Use the FLC" will be presented.

STRENGTHENING TECHNOLOGY TRANSFER AS A NATIONAL RESOURCE

Technology transfer evokes a variety of challenges to achieve what is, in effect, a cultural revolution. We in the government sector expect diverse institutions and individuals to cooperate. The agencies and laboratories are expected to provide technical expertise and initiate and negotiate challenging contractual and financial issues, and to do so rapidly. One of the Consortium's primary responsibilities is to develop the infrastructure and national interest for cooperation between the Federal laboratories and public and private sectors.

REGIONAL EMPHASIS

The Consortium's six geographic regions are the backbone of its national networking. The regions have developed advisors from the user communities, as required by the Federal Technology Transfer Act of 1986. These regional advisors are identified in Appendix III. Direct financial support to regional programs began in 1988. Each region has made major strides in strengthening cooperation among the Federal laboratories and with business and governments in the regions.

Northeast: The region is developing a brochure highlighting individual laboratories' available resources for business, in cooperation with State economic development programs. Cooperating with the Mid-Atlantic region, the Northeast laboratories are participating in a demonstration project, "Lablink", using a N.J. Institute of Technology electronic mail system to assist high-technology incubator facilities. Ultimately, a facilitator at each incubator will be trained to help small businesses gain access to the laboratories.

Mid-Atlantic: Working with the University of Maryland, promising technologies from individual laboratories will be packaged into information on Cooperative R&D Agreement opportunities for presentation to industry. This project is a prototype for a major meeting of business, Agency and laboratory leaders planned for 1990. Examples of technology ready for transfer and contact lists will be input to the Bell Atlantic Gateway System, an experiment in business information services.

Southeast: A dedicated FLC Regional Service Center, working in concert with the FLC Clearinghouse, has been established to provide outreach and direct access for the region at the Stennis Space Center, Mississippi. The projects described earlier in university centers of excellence and business spin-off case studies are projects in this Region.

Midwest: This Region organized the Manufacturing Technology Computer - Integrated Manufacturing conference described earlier. Cooperation with organizations such as the Ohio Technology Transfer Organization continued; based on this ongoing relationship, nearly 10% of OTTO's business requests were referred to Federal laboratories. This region also participated in the NIST's tristate workshop on technology transfer for State agents.

Midcontinent: In cooperation with the Far West Region a working relationship has been developed with the Center for the New West, a nonprofit organization with major emphasis on local economic development. On the basis of a detailed survey, 26 major Federal laboratories in this region, not previously involved in FLC activities, have been identified and contacted. The Oklahoma demonstration program with VOTECH was, in part, a project of this Region.

Far West: This Region has worked with the California Engineering Foundations forums on improving technology transfer to entities within the state. The Far West is a party to the cooperation with the Center for the New West. The FLC relationship with the Electric Power Research Institute grew out of this region. The region's advisors are working to promote Federal technology transfer through their constituent communities. The special session at an American Chemical Society meeting, described later, was organized by this region.

WASHINGTON, D.C. REPRESENTATIVE

In 1988 the Washington, D.C. Representative continued to develop and maintain relationships with a variety of public and private sector organizations. These working relationships, including the Industrial Research Institute, the American Chemical Society, and the American Society for Engineering Education, described elsewhere in this report, are examples of the Representative's efforts. An increased demand for technology transfer interactions has resulted from his contacts, meetings and presentations to national organizations headquartered in the Washington, D.C. area.

BUILDING LABORATORY INFRASTRUCTURE:

The Consortium offers the laboratories assistance in improving the skills of their technology transfer personnel and in improving their internal support for technology transfer.

Transfer Methods: Through its organized semiannual meetings, the Consortium provides exposure for technology transfer officials to a variety of working cooperation models, with the opportunity for in-depth assistance. Topics in 1988 included: What Industry is Seeking from the Federal laboratories; Patenting and Licensing Experiences (GOGO and GOCO Sessions); Cooperative Research and Development Agreements; Licensing and Royalties; Breaking the Barriers to Laboratory Interactions with Small Business; Progress in Technology Transfer Across the Federal agencies; R&D: the New Agenda and the New Alliances; How Can Trade Associations Help?

A Technology Ferret program, modeled on a British effort, was planned in 1988. The first demonstration of this program will be at the Naval Underwater Systems Center, where an industry retiree will work with the laboratory patent counsel to "ferret" out technologies and expertise of previously unrecognized value to industry.

Support for the development of laboratory spin-offs to small business is being provided by the training case study project described earlier.

Several years ago the Consortium funded testing of the value of technology expositions to the laboratories, with negative results. However, with the recent surge in business participation in these expositions, the FLC is reevaluating this endeavor in 1989.

Training: Legislative changes and practical experience are increasing the demand for targeted training for individuals assigned to technology transfer. The FLC Training Subcommittee made a survey of laboratory needs and has evaluated prior training sessions. These efforts have led to two sets of training efforts:

- A new half-day program, "FLC Fundamentals", has been developed to bring new laboratory representatives up to speed rapidly in both technology transfer and the value and operation of national-scale, inter-laboratory cooperation. Topics include Patents and Licensing, Cooperative R&D Agreements, Marketing, Militarily Critical Technology Issues and FLC Operations including Clearinghouse support.

- Professional training of laboratory representatives has been strengthened. In 1988, a half-day tutorial on intellectual property and a session on the details of patent licensing agreements were held. Advanced training in use of the FLC electronic mail system was also provided. Plans were made (and carried out in early 1989) to develop and present a detailed training session on Cooperative R&D Agreements, and to issue an RFP for special training presentations to the FLC representatives.

Awards: In 1984 the Consortium established annual Awards for Excellence in Technology Transfer. They are made to recognize and encourage extraordinary efforts in technology transfer. These awards are available only to individuals whose job assignment is not technology transfer, thereby reinforcing the emphasis on direct person-to-person cooperation. These FLC awards have become recognized by the laboratories and agencies as both prestigious and productive. The 1988 FLC Award Program recipients are listed in Appendix I.

NATIONAL COMMUNICATIONS INFRASTRUCTURE

An important national effort by the Consortium is the development of efficient communications among laboratories. As required by the Technology Transfer Act, electronic means for supporting this network have been developed.

Electronic Mail and Resource Directory: At present 71 laboratories, 7 advisors and 11 FLC related organizations have been linked by an electronic mail system characterized by simplicity, efficiency and a friendly in-house system manager. A Resource Directory, a keyword-based listing of laboratory expertise, now covers 168 laboratory facilities.

Clearinghouse: The Consortium Clearinghouse was established in July, 1987; it serves as an important tool for laboratories and requestors in assisting them to contact Federal laboratory staff. In early 1989 the clearinghouse function was strengthened by the establishment of a satellite FLC Service Center for the Southeast Region at the Stennis Space Center with assistance from NASA. The Clearinghouse is a primary resource for the FLC network that matches requests for technical assistance with Federal laboratory capabilities and expertise. It also provides a significant entry point into the network for requestors that contact the Clearinghouse directly. To locate appropriate laboratory capabilities and expertise the Clearinghouse uses the Resource Directory and other available systems, then uses personal contact with those laboratories' technology transfer offices to identify the key technical individual. In 1988, the Clearinghouse responded to inquiries from 38 states from the following sectors:

Large Businesses 35%
Small Businesses 42%
State & Local Government 5%
Universities 7%
Others 11%

Of these inquiries, 71% (337 requests) cited a specific technical interest, with the remainder requesting general information. The regional breakdown of these inquiry sources is:

Northeast 23%
Mid-Atlantic 15%
Southeast 10%
Midwest 15%
Midcontinent 18%
Far West 18%

A user evaluation survey and follow-up tracking system have been implemented to provide for increased effectiveness and quality of the Clearinghouse function. This effort has already led to improvements in timeliness and usefulness of its activities. The Clearinghouse resources have been augmented by installation of the DIALOG data base on CD-ROM, the Federal Applied Technology Data Base, and the Technology Targeting Database which identifies industry's interests, procured under an FLC model demonstration project.

Current trends indicate that the Clearinghouse will be referring over 100 specific requests per month by mid-1989.

Technical Specialists: To provide depth as well as breadth of services to its members, the FLC has identified representatives of FLC member laboratories/centers with necessary technical expertise to provide answers about state-of-the-art information and technology. The technical specialists are available as resource persons to help FLC representatives respond to queries and also assist the FLC Clearinghouse as a complement to the Resource Directory Data Base.

PROMOTING TECHNOLOGY TRANSFER

Many organizations are unaware of the availability and value of Federal laboratory technology transfer. Both awareness and interest need to be developed further through an extended effort.

In response to industry requests for more in-depth information on case histories of transfer experience the Consortium published a report entitled "Putting Technology to Work" in early 1988. The report documents 138 examples from 31 laboratories, and provides valuable insight into the process of Federal technology transfer. The Consortium continues to document case histories and examples and plans to publish a similar document in 1989.

The FLC was invited to present a symposium on Federal laboratories and technology transfer at the American Chemical Society (ACS) national meeting in Los Angeles. The Symposium was presented for the ACS Small Chemical Businesses Division and topics included an overview of the FLC, government/industry conferences, cooperative programs, case studies, and the industry perspective from a recipient of a Federal technology. The FLC also provided an exhibit for the Symposium.

The FLC Awards Program described elsewhere in the report has focused attention on technology transfer both within the government and in industry and the public sector. Major articles on the FLC and the technology transfer in technical trade magazines have yielded hundreds of serious industry contacts.

Many of the initiatives and programs described elsewhere in this report serve also to promote substantive cooperation.

SPECIAL ORGANIZATIONAL COOPERATION

The Consortium has concluded formal agreements with several organizations for cooperation in technology transfer. Parties and the objectives of these agreements are listed below.

National Institute of Standards and Technology: delineates the organizational relationship required by the Technology Transfer Act. Greater cooperation under the Omnibus Trade and Competitiveness Act is described in a later section.

Electric Power Research Institute: provides for cooperation in identifying Federal laboratory technology and expertise to the electric utilities.

Center for the New West: with the Consortium's Mid Continent and Far West Regions, to cooperate on economic development.

NASA - Technology Utilization Program: provides an umbrella understanding between NASA Technology Utilization activities and the FLC, especially relating to NASA Industrial Applications activities.

NASA - Applications Centers: builds on the NASA umbrella agreements and provides for regional cooperation in responding to the technology needs of the applications center's clients. Two regional agreements have been signed; in the Southeast and Far West Regions.

Oak Ridge Associated Universities: encourages 49 colleges and universities to work more closely with the Federal laboratories.

Building Research Board, Public Facilities Council, National Academy of Sciences: provides laboratory assistance and expertise to State and local governments on the leading edge of construction technology. This agreement has been effected by five laboratories briefing the Public Facilities Council and by FLC participation in two symposia organized by the Council and the American Public Works Association.

National Technical Information Service: formalizes the linkage required under the Stevenson-Wydler Act and the Technology Transfer Act.

U.S. Conference of Mayors: provides formal Consortium linkage to U.S. cities through the Conference of Mayors.

STRATEGY DEVELOPMENT

The Consortium's Strategic Plan approved October, 1987 has provide long range guidance for the FLC technology transfer effort. The document has been reviewed and generally still represents the Consortium's long-range direction. The continued relevance of the plan to changing requirements, is clarified later in this report relating to NIST cooperation and the Omnibus Trade and Competitiveness Act.

DEMONSTRATION PROJECTS

As required by the Federal Technology Transfer Act of 1986, model demonstration projects have been awarded to nonprofit organizations. In the first, recently completed project, the Utah Research and Education Foundation adapted its Technology Targeting Database for use by Federal laboratories. This database provides easy access to the technology acquisition interest of over 1000 companies. Software for rapid preparation of technology licensing documents was also developed.

The second project was competed in 1988 and awarded to the U.S. Conference of Mayors (USCM) in early 1989. In this project, the USCM will undertake four tasks:

- Work with 6 cities and nearby Federal laboratories to encourage the use of Federal technology in municipal services and facilities and to foster economic development.
- Work to develop and implement technical volunteer programs involving laboratory retirees in 3 other cities.
- Form and use an advisory group of mayors to assist in replication of the first two programs.
- Hold two workshops for mayors and other city officials to develop partnerships with laboratories.

Each project has garnered a 50% cost sharing by the performing organizations.

ADMINISTRATION AND EXPENDITURES

The Consortium appreciates the efforts of the National Institute of Standards and Technology in collecting the set-aside payments required by the Technology Transfer Act, and particularly its willingness to provide advance funds in anticipation of these set-aside receipts.

Details of the set-aside payments, voluntary laboratory support and the Consortium's 1988 expenditures are given in Appendix II.

CONSORTIUM PLANS

Earlier sections indicate plans which strengthen various aspects of technology transfer directly and through infrastructure development. Priority emphasis will be in five areas:

STRENGTHENING REGIONAL OPERATIONS

Critical to the success of the Consortium are strong Regional Operations. Beginning in 1988, funds were available for regional efforts. Strengthening the FLC presence in the regions will continue. Plans include improvements of entry points to the FLC Clearinghouse locator function for handling requests, increased laboratory involvement in the region, and mechanisms for a broader range of contacts with small businesses. Administrative support will be provided to the Regional Coordinator to facilitate these plans. The activities are expected to provide a broader understanding of the regional laboratory expertise and the regional users. Cooperative efforts with the regional laboratories, county, State and local technology groups are expected to increase.

TRAINING

A primary function and high priority for the FLC has been to provide training for its member laboratories. These efforts will continue and focus on new member training, electronic mail use and other mechanisms to strengthen the FLC network, marketing of laboratory technologies, and communications and presentation skills. Future training activities include the development of guides describing the FLC, managing the transfer process, and establishing cooperative research and development agreements. Case studies are also being written describing spin-off companies created through successful transfer of laboratory technologies. The case studies are being prepared following sound instructional design principles and will be used for training purposes.

ENVIRONMENT FOR TRANSFER

FLC experience and university studies confirm that the most effective technology transfers occur when the potential user identifies a need and gets together with the providers of a technology that could meet that need. An important contribution the FLC has made is to create opportunities for that contact or linkage to occur. Thus, the Consortium will increase the availability of such opportunities through linkages with other networks and cooperation with key professional societies and other organizations. Special transfer support programs will be created such as workshops focused on needs identified by industry and seminars directed at State extension services and small businesses. The IRI hazardous materials workshop and VOTECH relationship described earlier are examples of this approach. While the IRI effort is only recently underway, the VOTECH success has provided valuable experience for the Consortium and State extension agents. This experience is forming a base for small and medium sized business interactions described under the Omnibus Trade and Competitiveness Act. The Electric Power Research Institute is another example of efforts which focus on previously identified needs. That relationship combined with the effort described in the Center for the New West cooperation is expected to form the base for a general utility initiative.

ORGANIZATIONAL EFFECTIVENESS

Team efforts of the laboratories and Agencies in concert with the FLC continue to contribute to the effectiveness of each organization's transfer effort in meeting the national challenge. In order to provide effective support, coordination, and leadership, plans are underway to strengthen the Regional Coordination and Standing Committee structure. These will continue through efforts such as the establishment of a Program Subcommittee, formation of a speakers bureau, and steps to strengthen the representative network as a clearinghouse for requests for technical assistance and expertise. Specifically a consistent message which accurately explains what the FLC is and is not and how to access its service will be widely delivered to user groups. Also, mechanisms will be implemented to make agency level policy makers and laboratory directors more aware of the FLC and to encourage their input and support. The public awareness and credibility of the FLC is expected to increase along with the organization's continuing ability to meet the legislative mandate of the Consortium and its member laboratories and agencies.

COOPERATION WITH NIST

Beginning in 1987, the Consortium and the NBS maintained a dialog on how to cooperate under the proposed new NIST responsibilities under the Omnibus Trade and Competitiveness Act. Close interaction began immediately after enactment, leading to early program planning and a detailed agreement draft on formal cooperation under the State Technology Extension Program. These cooperative efforts directly relate to and support the approved FLC 1987-92 Strategic Plan and our current operations plan.

Four specific areas of joint effort are anticipated:

- Partnership in sponsoring workshops and seminars for State officials and technology extension agents, aimed both at developing the state-level infrastructure to support technology transfer and at targeting specific technology areas of local interest;
- Providing State technology extension programs with training in accessing the FLC Clearinghouse function;
- Participation in projects to demonstrate the effectiveness of transfer methods developed under the Cooperative Agreements thrusts of NIST's State Technology Extension Program; and
- Cooperation in providing advice and assistance to the states establishing technology extension programs.

As examples of early cooperation, NIST participated in the FLC's program in Oklahoma (described earlier under Small Business), and the FLC participated in an NIST workshop for State agents from Ohio, West Virginia and Pennsylvania.

ISSUES

Evaluation: Within the next few years, it will be valuable to have the Consortium's program, as well as Federal technology transfer programs in general, evaluated to assess program impact and recommend changes where indicated. This is anticipated to be a challenging process because of the multiple nonquantitative objectives in the range of activities under the umbrella of "technology transfer".

New Cooperation Models: In certain cases, the use of Federal funds by a private party could be a prerequisite for industry-laboratory collaboration. Consideration might be given to authorizing a new form of Agreement that would allow use of Federal funds.

Extension of Cooperative R&D Agreement Authority: At present, only Federally-operated technical organizations may enter into Cooperative R&D Agreements. Extension of this authority to include explicitly Government-Owned Contractor-Operated facilities, as well as Federal Contract Research Centers, would broaden the value of this mechanism to the U.S.

Freedom of Information Act: The Act exempts from disclosure information that is critical to a company's competitive commercial position. This provision does provide some comfort to companies entering into Cooperative R&D Agreements with Federal laboratories, but it would be valuable to have further guidance on the practical application of this exemption.

Software: These is a growing perception that the inability of the government to copyright computer software written by its employees is providing foreign industry with an opportunity to commercialize this software. Some attention to this issue would assist measurably in completing an intellectual property policy basis for industry-laboratory cooperation.

Foreign Industry: Although the government's intent on technology transfer is clear - to strengthen the U.S. economy and its international competitive positions - there remain some policy ambiguities. The greater issue is the definition of an American company; for example, should a laboratory prefer to work with a US-based company that would use laboratory technology for foreign manufacture, or a foreign-based company that will clearly do its development and manufacturing in the US?

Technology Export Controls: The Consortium wishes to make explicit its understanding of the dual requirements of domestic technology transfer and respect for controls on availability of technology or information to foreign entities. Indeed, a presentation on this topic is a major element in the "FLC Fundamentals" training for new technology transfer personnel; it is felt that training individuals from non-Defense organizations as well as from Defense laboratories strengthens the infrastructure of necessary controls.

DOMESTIC TECHNOLOGY TRANSFER

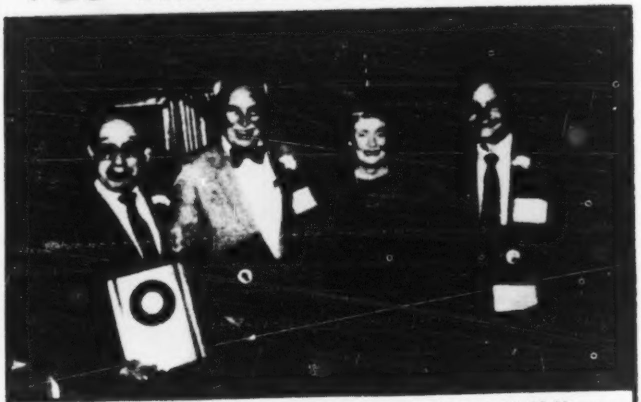
APPENDIX I

The FLC NEWS

* FEDERAL LABORATORY CONSORTIUM FOR TECHNOLOGY TRANSFER *

JUNE 1988 VOL.4 NO.5

FLC AWARDS RECIPIENTS HONORED!!



l to r: Dr. William Marcuse, Dr. Robert A. Ramey , Margaret M. McNamara and Dr. Eugene E. Stark at the 1988 FLC Awards Banquet

HAROLD METCALF AWARD:

This award recognizes the sustained significant service to the Consortium, its programs and process, of an individual FLC Representative. The award is for service over a three-to-five year period. Mr. Metcalf was the first Federal laboratory program manager at the National Science Foundation. He was responsible for integrating the Federal laboratory program into the intergovernmental science program at the Foundation, and instrumental in expanding the Department of Defense Consortium for Technology Transfer to the current government-wide FLC. This award recognizes Mr. Metcalf's contribution, as well as those of the former and future recipients. We are pleased to award the Metcalf Award to:

DR. EUGENE E. STARK, LOS ALAMOS NATIONAL LABORATORY

For improving, through executive excellence, the national climate for technology transfer from Federal laboratories.

The FLC Awards for Excellence In Technology Transfer were announced May 17 in Washington, D.C. Nominations for the award are solicited annually from more than 350 FLC member labs. Winners are evaluated by a panel of experts in Tech. Transfer, including reps. from government, academia and labs. FLC Vice-Chair Margaret M. McNamara, who chairs the Award Committee and administers the awards programs presented the awards. The three "Awards of Appreciation" follow with others honored listed on pages 3 and 4.

REPRESENTATIVE OF THE YEAR :

This award recognizes the individual FLC Representative who has made the most significant contribution to the FLC program in the past year. The award is for service in the past year. This year, we are happy to present this award to:

DR.WILLIAM MARCUSE, BROOKHAVEN NATIONAL LAB.

For raising national awareness of new integrated circuit technologies and promoting industrial cooperation with Federal laboratories.

AWARD OF APPRECIATION:

This award recognizes individuals, who are not FLC Representatives or alternates, for a notable contribution to the FLC in terms of support and/or service. This year's recipient is:

DR. ROBERT A. RAMEY, UNIVERSITY OF FLORIDA

For his commitment to increasing cooperative efforts between universities and Federal laboratories.

FLC AWARDS PROGRAM RECIPIENTS

The FLC Awards For Excellence In Technology Transfer were established in 1984. The award recognizes the excellence of federal laboratory employees, who are not FLC representatives, and who have exceeded their responsibilities by their outstanding work in transferring technology to other organizations. These award winners are individuals whose activities clearly merit national recognition. The following individuals were honored by the Consortium:

ARMY BENET LABORATORIES

PETER A. THORNTON, JOHN ATCHINSON

For their aggressive, persuasive efforts in transferring Hot Isostatic Pressing technology to private industry for the production of large high-strength components.

NASA LANGLEY RESEARCH CENTER

WARREN C. KELLIHER

For development of portable element analyzers for geologic and toxic waste site surveys, and transfer of the technology to the Bureau of Mines and EPA.

ARMY CHEMICAL RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

JOSEPH M. LEONARD, GEORGE R. FAMINI, WILLIAM P. ASHMAN

For excellence in developing and promoting an innovative, sophisticated and integrated software package used by scientists to predict chemical, physiological and physical behavior of chemicals prior to their synthesis.

FERMI NATIONAL ACCELERATOR LABORATORY

PHILIP V. LIVDAHL

For developing the hospital-based proton therapy accelerator and transferring the technology to the medical community.

NAVAL CIVIL ENGINEERING LABORATORY

JAMES F. JENKINS

For outstanding dedication and creativity in the transfer of materials and corrosion engineering technology to the public and private sectors.

ARMY TANK-AUTOMOTIVE COMMAND RDE CENTER

RONALD R. BECK

For initiative and dedication in the development and transfer to the private sector of dynamic system simulation technology and software.

LAWRENCE BERKELEY LABORATORY

IAN G. BROWN

For the design, development and active transfer of the microMEVVA and MEVVA (metal vapor vacuum arc) ion source technologies to industry and to educational institutions.

LAWRENCE BERKELEY LABORATORY

MIKE RUBIN, DARIUSH ARASTEH, STEPHEN SELKOWITZ, SUE REILLY, JOHN HARTMANN

For the development and creative technology transfer of the WINDOW 2 thermal performance program to the diverse window and insulating glass industry.

NOAA, NATIONAL WEATHER SERVICE, HYDROLOGIC RESEARCH LABORATORY

DANNY L. FREAD , JANICE M. LEWIS

For their contribution to the transfer of techniques that forecast river flows for improved water management and forecast specific flows resulting from dam failures.

BROOKHAVEN NATIONAL LABORATORY

SURESH SRIVASTAVA

For unusual initiative in introducing the red blood cell kit to industrial sponsors and convincing them to commercialize it for use in millions of clinical examinations annually.

BROOKHAVEN NATIONAL LABORATORY

DMITRI STEPHANI

For creativity in inventing hybrid preamplifiers and uncommon initiative in promoting commercialization through assisting manufacturers to produce, advertise and market thousands of units annually.

AIR FORCE WRIGHT AERONAUTICAL LABORATORIES

BRIAN M. KENT, JAMES M. COMMON, JOHN P. SKINNER, DARLENE J. HERBERT

For leadership, dedication, and initiative in conceiving, organizing, and distributing a "Frequency Selective Surfaces" short course, manuals, and computer software, and in the transfer of this technology to a broad range of government and industry users.

ARMY NATICK RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

CEASAR BRAGA

For the rapid transfer to the public sector of a new technology for the protection of Explosive Ordnance Disposal Personnel.

NATIONAL BUREAU OF STANDARDS

ROBERT J. CELOTTA

For developing cooperative ventures with industry to measure magnetic microstructure of new materials with the NBS magnetic microscope.

IDAHO NATIONAL ENGINEERING LABORATORY

B.R. "BUD" ALBIN, R.A. "DICK" MITCHELL

For the initiative and technology transfer efforts demonstrated in organizing the Volunteers for Medical Engineering, Inc., Idaho Falls Chapter.

DANIEL R. CORSBERG, MICHAEL A. BRAY

For the initiative and creativity demonstrated in transferring the INEL technology, Alarm Filtering System, to users outside the nuclear safety industry.

FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE

ARTHUR H. JUKKALA

For superior performance in the development and transfer of technology relative to the safety of Federal, State and local wildland firefighters.

JOHN B. CRIST

For outstanding contributions to the development and implementation of timber bridge technology.

SANDIA NATIONAL LABORATORIES

LAWRENCE W. TEUFEL

For the development of the anelastic strain recovery technique of in situ stress measurement and initiative in arranging cooperative programs for transfer to industry.

ARGONNE NATIONAL LABORATORY & NATIONAL BUREAU OF STANDARDS

DAVID S. KUPPERMAN , MELVIN LINZER

For excellence in a cooperative effort with a trade association and private industry to develop an ultrasonic flaw detector for hot steel.

AIR FORCE GEOPHYSICS LABORATORY

ALLEN G. RUBIN, DAVID L. COOKE, CHARLES P. PIKE

For developing and transferring Satellite Design technology to industry, thereby successfully increasing the reliability of military, civil and commercial satellites.

NASA LEWIS RESEARCH CENTER

BRUCE A. BANKS

For his efforts to transfer intercalated graphite fiber technology to private industry and develop new commercial products using this material.

RICHARD K. SHALTENS

For his efforts in transferring NASA-DOE Stirling cycle engine technology to the automotive industry.

LOS ALAMOS NATIONAL LABORATORY

RICHARD MAH, WAYNE BONGIANNI, ANTON MAYER, JOEL WILLIAMS

For creativity and persistence on successful transfer of materials and instrumentation technology to GV Medical, Inc., in the field of laser angioplasty commercialization.

JAMES L. SMITH, TERRY C. WALLACE

For development of an innovative cooperative program with the Public Service Company of New Mexico on high-temperature superconductivity research and development.

ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY

FRANK KEARNEY, DEBBIE LAWRENCE

For completing the first Cooperative Research and Development Agreement in the Army under the Technology Transfer Act of 1986 for the Voice-Activated Inspection System.

PACIFIC NORTHWEST LABORATORY

PETER M. MOLTON, ALEX G. FASSBENDER

For commitment to the development and transfer of a process for converting sewage sludge to fuel oil and steadfast pursuit of a successful alternative when initial commercialization efforts failed.

AMES LABORATORY, U.S. DEPARTMENT OF ENERGY

JAMES J. HOLL, O. DALE McMASTERS

For extraordinary effort in helping to establish a facility and an operation for the commercialization of Terfenol-D, a promising new magnetostrictive material.

NAVAL RESEARCH LABORATORY

NORMAN C. KOON

For his novel research, development, and technology transfer on rare earth magnetic alloys and their application in a variety of fields.

OAK RIDGE NATIONAL LABORATORY

S.A. MEACHAM, E.C. BRADLEY

For development of ORNL's first agreement involving licensing of both patents and copyrights and a companion cooperative agreement (REMOTEC/DOE) leading to commercialization of Advanced ServoManipulator/Control System technology.

APPENDIX II

1988 FINANCIAL SUMMARY

FEDERAL LABORATORY CONSORTIUM FOR TECHNOLOGY TRANSFER

CALENDAR 1988 EXPENDITURE REPORT

Program Element	**Expenditures** (Thousands)
Management and Administration	
Executive Management	$ 32.4
Operations Management	157.2
Washington, DC Representative	173.1
Operations and Member Services	
Meeting support	66.8
Training	7.3
Communications (1)	28.3
Clearinghouse	104.8
Outreach Program	
Outreach Materials & General Support	36.0
Exhibits	10.1
Demonstration Project (2)	18.0
Regional Support (3)	140.0
Total 1988 Expenditures	**$ 774.0**

Note that expenditures are reported based on the 1988 period of performance rather than on accounting entries or payments related to the Government's fiscal year.

NOTES:

1) Includes estimated costs of $12,000 for E-Mail.

2) Represents disbursements only. Five percent mandated set-aside for Phase I & II procurements totals $122,000 committed funds.

3) Due to late receipt of Agency set-aside funds, budgeted support to regional operations was delayed until late in 1988.

FY 1988 RECEIPTS

The National Institute of Standards and Technology reports the following set-aside receipts for FY 88 by Department:

Department	**Received** (Thousands)
Department of Agriculture	$ 25.5
Department of Commerce	13.1
Department of Defense	
Air Force	14.3
Army	126.0
Navy	166.3
Department of Energy	227.0
Department of Health and Human Services	
National Institues of Health	35.2
Department of the Interior	16.6
National Aeronautics and Space Administration	77.5
Set-Aside Receipts (1)	**$ 701.5**
Voluntary Contributions (2)	**72.0**
Total FY 1988 Funds Received	**$ 773.5**

NOTES: 1) Twenty percent of the FY 88 set-aside funds were received in FY 89.

2) Represents contributions from headquarters and individual laboratories of the Departments of the Army, Navy and Energy.

APPENDIX III

The Federal Laboratory Consortium - ORGANIZATIONAL ELEMENTS

EXECUTIVE COMMITTEE:

Chairman:

Dr. Loren C. Schmid
DOE-Pacific Northwest Laboratory
PO Box 999, MS KI-34, Richland, WA 99352

Vice Chairman:

Ms. Margaret M. McNamara
DOD-Naval Underwater Systems Center
Code 107, Bldg. 80T, New London, CT 06320

Regional Coordinators:

Mr. Robert M. Barlow
NASA-John C. Stennis Space Center
Code HA00, Stennis Space Center, MS 39529

Ms. P. Sinclair Ingalls
DOD-Wright R&D Center
WRDC-XO Room 151, W-PAFB, OH 45433-6523

Mr. Clifford E. Lanham
DOD-Army Harry Diamond Lab, SLCHD-TT
2800 Powder Mill Rd., Adelphi, MD 20783

Dr. William Marcuse
DOE-Brookhaven National Laboratory
Building 475-b, Upton, NY 11973

Mr. Robert P. Stromberg
DOE-Sandia National Laboratories
TT Org.4031, Albuquerque, NM 87185-5800

Mr. Charles Miller
DOE-Lawrence Livermore National Lab
PO Box 808-L795, Livermoree, CA 94550

NBS Representative:

Mr. James Wyckoff
DOC-National Institute of Standards & Technology

At-Large Members:

Mr. Len Ault
NASA Headquarters

Mr. Jerome Bortman
DOD-Naval Air Development Center

Mr. James Hall
DoAg-Agricultural Research Service

Ms. M. Connie Harrisson
DOD-Army Belvoir RD&E Center

Mr. Donald Jared
DOE-Oak Ridge National Laboratory

Mr. H. Dana Moran
DOE-Solar Energy Research Institute

Dr. Jane M. Welch
DOE-Idaho National Engineering Laboratory

Mr. Daniel E. Williams
DOE-Ames Laboratory

Ad hoc Members:

Ms. Maylene Duenas
NASA-Ames Research Center

Ms. Tina M. McKinley
DOE-Oak Ridge Associated Universities

Mr. Nick Montanarelli
Strategic Defense Initiatives Org.

Dr. Eugene Stark - MS H-811
DOE-Los Alamos National Laboratory

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Chairman:

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Univ. of Missouri-Rolla
211 Parker Hall, Rolla, MO 65401

National Members:

Mr. L. Badin
Rockwell International, Downey, CA

Dr. J. Jolly
Calif. State Univ., Sacramento, CA

Mr. N. Kessler
A.E. Staley Mfg. Co., Decatur, IL

Dr. R. Ramey
University of Florida, Gainesville, FL

Dr. D. Swanson
Georgia Tech., Atlanta, GA

Regional Members:

Dr. Stanley H. Smith
Northeast Region

Dr. H. Leroy Marlow
Mid-Atlantic Region

Dr. R. M. Moore
Far West Region

FAR WEST REGIONAL ADVISORS

Chairman:

Dr. R.M. Moore
Chevron Research Company
PO Box 1627, Richmond, CA 94802-0627

Members:

Mr. Leslie Badin, Jr.
Rockwell International Corp., Downey, CA

Dr. Richard B. Block
Electric Power Research Inst., Palo Alto, CA

Mr. Donald I. Carter
Rockwell International Corp., El Segundo, CA

Mr. Bill Grinstein
Econ. Dev. Partnership for WA, Seattle, WA

Dr. James A. Jolly
California State University, Sacramento, CA

The Honorable S. Hankins
Washington State Legislature, Olympia, WA

Mr. Andrew Paterson
RIM Tech, Pasadena, CA

Dr. T.L. Purce
Idaho State University, Pocatello, ID

NORTHEAST REGIONAL ADVISORS

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- Rotating

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MIT Materials Processing Ctr, Cambridge, MA

- Mr. Stanley H. Smith
  Stevens Institute of Technology

Dr. Herbert Freeman
State Univ. of NJ, Rutgers, New Brunswick, NJ

Ms. Megan Jones
Mass. Ctr. of Excellence Corp., Boston, MA

Mr. Mark S. Tebbano
NY State S & T Foundation, Albany, NY

Dr. David M. Goodman
New Jersey Commission on S & T, Trenton, NJ

Dr. Arthur Obermayer
Moleculon, Inc., Cambridge, MA

Mr. Eric Ott
Connecticut Tech. Assistance Ctr, Hartford, CT

Mr. Bruce R. Lang
Rhode Island Partnership for S & T, Providence, RI

Dr. Modesto Iriarte
Puerto Rico Electric Power Auth., San Juan, PR

Ms. Patricia Tanski
Main S & T Commission, Augusta, ME
Mr. Allan C. Jones
Digital Equipment Corp, Maynard, MA
*Regional Representative to National Advisory Group

SOUTHEAST REGIONAL ADVISORS

Members

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Dr. James Miller
Mississippi Technology Transfer Center, MS
Mr. Robert Ramey
University of Florida, Gainsville, FL

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Iowa SBDC, Ames, IA
Mr. Roger Eldridge
US West Advanced Technologies, Engelwood, CO
Mr. John H. Dendahl
N.M. Econ. Dev. & Tourism Dept., Santa Fe, NM
Mr. Richard Chapman
Chapman Research Group, Inc., Littleton, CO

MIDWEST REGIONAL ADVISORS

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Michigan Technical Council, Ann Arbor, MI
Mr. Larry Crockett
University of Mich. Institute, Ann Arbor, MI
Mr. F. Tim Janis
Aerospace Res. Application Ctr., Indianapolis, IN
Mr. Jeff Shick
Ohio Tech. Transfer Organ., Columbus, OH
Mr. John Strauss
Illinois Commission on S & T, Chicago, IL

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Chairman:

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E.I. DuPont, Wilmington, DE
Dr. Gene Calvert
Center for Innovation Technology, Herndon, VA
Dr. Norman Estrin
Health Industry Mfg'er Assoc., Washington, DC
Dr. Walter Plosilla
High Tech. Council, Inc., Rockville, MD
Dr. John D. Sanders
Washington Technology, Vienna, VA
Dr. Rachael Thompkins
West Virginia University, Morgantown, WV

PLANNING & POLICY COMMITTEE:

Chairman:

Ms. M. McNamara
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Members:

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Mr. C. Miller
DOE-LLNL, Livermore, CA
Mr. A. Norris
FDA-NCTR, Jefferson, AR
Mr. T. Schoenborn
HHS-NIOSH, Cincinnati, OH
Dr. E. Stark
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BUDGET & FINANCIAL MANAGEMENT COMMITTEE

Chairman:

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DOC-NOAA, Boulder, CO
Mr. D. Williams
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INDUSTRY/GOVERNMENT/UNIVERSITY RELATIONS COMMITTEE

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EG&G, Miamisburg, OH
Mr. R. Barlow
NASA, Stennis Space Ctr, MS
Mr. W. Friedlander
3M, St. Paul, MN

Subcommittee on Small Business:

Chairman: Mr. J. Hall

Subcommittee on Governments:

Chairman: Mr. R. Dedic

Subcommittee on Universities:

Chairman: Dr. J. Gumnick

MARKETING & PUBLIC AFFAIRS COMMITTEE:

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Mr. C. Griffith
Miss. Tech. Transfer Office

Subcommittee on Awards:

Chairman: Ms. D. Jackson

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DOC-CUFT, Springfield, VA
Mr. P. Taylor
US F&WS, Fort Collins, CO

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FEDERAL LABORATORY CONSORTIUM FOR TECHNOLOGY TRANSFER

EST. 1974

THE FEDERAL LABORATORIES

- **Comprise over 600 Federal laboratories and centers;**
- **Have Annual in-house R&D budgets of approximately $20 billion; and**
- **Employ approximately 1/6 of the Nation's Research and Development professionals.**

THE FEDERAL LABORATORY CONSORTIUM

Chartered by the Technology Transfer Act of 1986 to strengthen technology-based cooperation between the Federal laboratories and US business, universities, State and local governments, and the Federal agencies.

Mr. Walgren. Thank you very much. Thank you, Dr. Schmid.

Then let's, in the order in which I introduced you to the record, we will turn then to Dr. Princen.

Dr. Princen. Mr. Chairman, I appreciate the opportunity to appear before your committee to discuss the Federal Technology Transfer Act of 1986 and its impact.

I'm accompanied today by Dr. William Tallent, Assistant Administrator of the Agricultural Research Service for Cooperative Interactions, the unit under which the activities under the act fall.

Since the enactment of the law and issuance of Executive Order 12591, mechanisms have been provided for solving some major problems, notably the need for closer interaction between public and private sector research establishments.

For well over 50 years, the Northern Regional Research Center and other Agricultural Research Service laboratories have conducted research to develop new knowledge, techniques, ~~processes~~ and products related to agricultural produce. This research in many cases was conducted with limited direct interaction with scientists and engineers from private firms.

Only after the work was completed would efforts be expended to entice the private sector to market the technology or product. Some successes were achieved, but the methods used for technology transfer were cumbersome.

Some successes include xanthan gum, a corn-based fermentation product used as a thickener in many food and industrial fluids, and superslurper, a highly absorbent corn-based product that is now used extensively in such products as diapers, wound dressings, body powders, batteries and agricultural applications.

The Act allows the agency now to cooperate closely with private partners during the research process, to negotiate patent rights of any intellectual property that might accrue from such cooperation and to return part of the royalties received from patent licensing to the inventors.

All three aspects of the Act have already affected agricultural research throughout ARS. To date, we have entered into 66 Cooperative Research and Development Agreements with industrial firms and at least 32 more are under negotiation.

At the Northern Regional Research Center, Cooperative Research Agreements are now in place with the Biotechnology Research and Development Corporation, which is under discussion here today, and will be presented later on by Mr. Brewen, as well as with several other companies and associations.

The BRDC has already funded five research agreements at the Northern Regional Research Center and is negotiating several more. One major agricultural company has hired three scientists and stationed them at the Northern Center to augment our staff assigned to three specific research projects of particular interest to the company.

This appears to be an excellent approach. One, it spreads—it speeds up the projects without burdening the Federal resources available; and two, it gives the company the opportunity to build on the technology transfer process at an early point of its commitment.

Under the Act, one company signed a cooperative agreement to conduct scaled-up studies on a Northern Center process which could not have been conducted otherwise by the government and would have been too expensive to contract out.

The company also obtained an exclusive license on the patented technology. This cooperation resulted quickly in successful test marketing of the product, the construction of a new manufacturing plant, new employment opportunities and royalties for the government and for the inventors.

Other cooperative agreements are already in place and implemented to cooperatively develop starch-filled plastics, soybean oil-based printing inks, high-yielding corn of improved hardness for export markets, and to evaluate natural products as safer pesticides.

The act has also had strong impact in other ways. It has improved the processing of exclusive licenses of patents that have resulted from ARS research accomplished without the benefit of an industrial co-sponsor. It also has served to stimulate our scientists in seeking patents for their inventions.

In the past, many scientists believed that patents were not important as long as they published their technical developments in the scientific journals. Little credit was given for patents and there was no monetary benefit.

Since the implementation of the Act, the agency's patent staff has already been increased 50 percent, but scientists not only want patents issued as soon as possible, they expend much effort to facilitate the technology transfer operations in order that the research can be available to commercial practice as soon as possible.

Three aspects associated with technology transfer and industrial cooperation as mandated under the act may need additional attention: One, copyrighting of government-developed computer software; two, providing assurance to industrial cooperators that proprietary information shared under the program will be held in confidence; and three, reaffirming the spirit of the law as a simple and expeditious mechanism to enhance cooperation between government laboratories and industry

We must assure that industry is not overburdened with those aspects of the procurement process that are bureaucratic, time-consuming or unnecessary.

Mr. Chairman, this completes my prepared testimony. Dr. Tallent and I will be pleased to respond to any questions you might have.

[The prepared statement of Dr. Princen follows:]

STATEMENT OF

DR. L. H. PRINCEN

DIRECTOR, NORTHERN REGIONAL RESEARCH CENTER, PEORIA, ILLINOIS

AGRICULTURAL RESEARCH SERVICE

U. S. DEPARTMENT OF AGRICULTURE

BEFORE THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

U. S. HOUSE OF REPRESENTATIVES

JUNE 1, 1989

Mr. Chairman, I appreciate the opportunity to appear before your Committee to discuss the Federal Technology Transfer Act of 1986 and its impact. I am accompanied today by Dr. William H. Tallent, Assistant Administrator of the Agricultural Research Service for Cooperative Interactions, the unit under which the activities under the Act fall.

Since the enactment of the law and issuance of Executive Order 12591, mechanisms have been provided for solving some major problems, notably, the need for closer interaction between public and private sector research establishments.

For well over 50 years, the Northern Regional Research Center (NRRC) and other Agricultural Research Service (ARS) laboratories have conducted research to develop new knowledge, techniques, processes and products related to agricultural produce. This research, in many cases, was conducted with limited direct interaction with scientists or engineers from private firms. Only after the work was completed would efforts be expended to entice the private sector to market the technology or product. Some successes were achieved, but the methods used for technology transfer were cumbersome. Some successes include xanthan gum, a corn-based fermentation product used as a thickener in many food and industrial fluids, and superslurper, a highly absorbent corn-based product that is now used extensively in such products as diapers, wound dressings, body powders, batteries and agricultural applications.

The Act allows the Agency now to cooperate closely with private partners during the research process, to negotiate patent rights of any intellectual property that might accrue from such cooperation, and to return part of the royalties received from patent licensing to the inventors. All three aspects of the Act have already affected agricultural research throughout ARS. To date, we have entered into 66 Cooperative Research and Development Agreements with industrial firms and at least 32 more are under negotiation.

At NRRC, cooperative research agreements are now in place with the Biotechnology Research and Development Corporation (BRDC) which is under discussion here today, as well as with several other companies and associations. The BRDC has already funded five research agreements at NRRC and is negotiating several more. One major agricultural company has hired three scientists and stationed them at NRRC to augment our staff assigned to three specific research projects of particular interest to the company. This appears to be an excellent approach: (1) it speeds up the projects without burdening the federal resources available, and (2) it gives the company the opportunity to build in the technology transfer process at an early point of its commitment.

Under the Act, one company signed a cooperative agreement to conduct scaled-up studies on a NRRC process, which could not have been conducted otherwise by the government and would have been very expensive to contract out. The company also obtained an exclusive license on the patented technology. This cooperation resulted quickly in successful test marketing of the product, the construction of a new manufacturing plant, new employment opportunities, and royalties for the government and for the inventors.

Other cooperative agreements are already in place and implemented to cooperatively develop starch-filled plastics, soybean oil-based printing inks, high-yielding corn of improved hardness for export markets, and to evaluate natural products as safer pesticides.

The Act has also had strong impact in other ways. It has improved the processing of exclusive licenses of patents that have resulted from ARS research accomplished without the benefit of an industrial cosponsor. It also has served to stimulate our scientists in seeking patents for their inventions. In the past many scientists believed that patents were not important, as long as they published their technical developments in the scientific journals. Little credit was given for patents and there was no monetary benefit. Since the implementation of the Act, the agency's patent staff has been increased 50 percent. Scientists not only want patents issued as soon as possible, they expend much effort to facilitate the technology transfer operations in order that the research can be available to commercial practice as soon as possible.

Three aspects associated with technology transfer and industrial cooperation as mandated under the Act may need additional attention:

(a) Copyrighting of government-developed computer software.

(b) Providing assurance to industrial cooperators that proprietary information shared under the program will be held in confidence.

(c) Reaffirming the spirit of the law as a simple and expeditious mechanism to enhance cooperation between government laboratories and industry. We must assure that industry is not overburdened with those aspects of the procurement process that are bureaucratic, time-consuming, or unnecessary.

Mr. Chairman, this completes my prepared testimony. Dr. Tallent and I will be pleased to respond to any questions you might have.

Mr. **Walgren.** Thank you very much, Dr. Princen. We appreciate that.

Then let's turn to Mr. Stern.

Mr. **Stern.** Good morning and thank you, Mr. Chairman, for inviting me to give this presentation.

Mr. **Walgren.** Glad you're here.

Mr. **Stern.** I am from Electronics Technology and Devices Laboratory, and during the past year, our laboratory, better known as ETDL, initiated implementation of the Tech Transfer Act of '86 by establishing several Cooperative Research and Development Agreements, CRDAs, with numerous other CRDAs being affected—or will be affected soon.

ETDL is one of seven R&D laboratories in the Army's Laboratory Command, LABCOM. Our laboratory consists of about 301 individuals, more than half of them being scientists and engineers, S&Es.

Our mission is to develop and maintain a continuously upgraded base in electronics technology and devices, develop the Army's electronic components and devices that support the next generation of combat systems, resolve chronic systems problems and explore advanced technology for future systems, or notional systems.

Since ETDL has state-of-the-art ongoing R&D in both in-house and contractually, we found that industry and academia were eager to work with us together because of our state-of-the-art equipment, our skilled technologists and advanced R&D capabilities that we have in our laboratory.

ETDL had no trouble putting together a list of at least 10 prospective CRDA teams within a matter of weeks. Formalizing our planned CRDAs was a bit more slow and difficult, though. This was due in part to the initial lack of regulations, guidelines and delegated authority to sign such agreements and to manpower shortages in our legal offices.

Most of these initial problems are now behind us since the Army now has interim guidelines and the authority to sign agreements has been delegated to laboratory directors. This has been done about a year ago, I think, April of '88, so that delegation has well long ago taken place.

Our laboratory has well-established CRDA procedures and has moved forward. A wealth of information has been gained by networking through the Federal Laboratory Consortium, the FLC, through various legal councils, other agencies, and through the Domestic Technology Transfer Manager, Mr. Clifford Lanham, such that the CRDA process has become a more routine procedure with minimal delays involved.

As an example, ETDL recently transitioned a highly successful Small Business Innovation Research, SBIR program, into a technology transfer program via a CRDA as encouraged by the Army, and also as encouraged by the act, since numerous times in the act, we're encouraged to involve small businesses and pay particular attention to them.

This SBIR effort initially resulted in an improved class of ferrite materials or ceramic magnetic materials similar to refrigerator magnets, but these materials are used for high-frequency switches millimeter wavelengths above the microwave frequency range which utilize these materials for performing circuit functions such as signal-switching and electronic antenna scanning and radar and communications systems.

This development is already impacting numerous DOD and NASA systems, the DOD MILSTAR system, NASA's active advanced communications technology satellite communications systems.

The follow-on CRDA now covers the test and evaluation of these particular devices under high-power operation and is now being carried out in ETDL's high-power millimeter wave test and evaluation facility by ETDL personnel and by contractor personnel under the CRDA.

The effort will aid in the development of devices capable of withstanding the higher power requirements in new radar and satellite communication systems for future military and also commercial applications.

ETDL has a number of CRDAs in effect or in various stages of preparation in the following areas of technology: In microelectronics for circuitry; nuclear magnetic resonance imaging, similar to the CAT scan, that kind of application; magnesium manganese dioxide batteries; solid-state materials and high-power solid state devices also for high-energy switching; high-frequency amplifiers in a microwave and a millimeter wave frequency range also.

All of these programs are related to ETDL's mission, but also have significant potential for commercial applications. These cooperative efforts typically run—or typically have from two to eight participants and include such companies and academic institutions as GTE, NYU School of Medicine, the RAYOVAC Corporation, University of Virginia, Research Triangle Institute, American Cyanamid, Polytech University, which used to be Brooklyn Poly, Electric Power Research Institute (EPRI), and numerous other ones that I won't mention here.

Although the CRDA process is becoming more of a routine function, each CRDA is usually significantly different from another. Some have two participants; some have eight participants; some require payment of cost to the government for use of highly specialized equipment and the operation of that equipment or energy cost, utility costs, the high cost of power being used in test and evaluation, and some CRDAs deal in basic R&D while others are concerned with test and evaluation.

In summary, we can say that CRDAs represent to all parties involved a new and innovative positive method of operation. All the participants are able to leverage their manpower, facilities and financial resources by working together as a team in order to solve common technological problems which they heretofore couldn't hope to solve individually on an individual basis.

Besides the Federal Government, industry and academia benefiting from this process, the country in general benefits because the technology base grows and high technology is more effectively and efficiently transferred to the commercial sector.

That concludes my presentation. I welcome any questions.

[The prepared statement of Mr. Stern follows:]

IMPLEMENTATION OF THE TECHNOLOGY TRANSFER ACT OF 1986
AT
ELECTRONICS TECHNOLOGY AND DEVICES LABORATORY

by

Richard A. Stern
Technology Transfer/Small Business Manager
U.S. Army Electronics Technology and Devices Laboratory
LABCOM, Ft. Monmouth, N.J. 07703-5000

ABSTRACT

During the past year the U.S. Army Electronics Technology and Devices Laboratory (ETDL) initiated implementation of the Technology Transfer Act of 1986 by establishing several Cooperative Research and Development Agreements (CRDAs), with numerous other CRDAs soon to be effected.

BACKGROUND

ETDL is one of seven R&D Laboratories in the Army's Laboratory Command (LABCOM). Our Laboratory consists of 301 individuals, more than half of whom are scientists and engineers. Our mission is to develop and maintain a continuously upgraded base in electronics technology and devices, develop the Army's electronic components and devices that support the next generation of army combat systems, resolve chronic systems problems and explore advanced technology for future systems.

DEVELOPING CRDAs

ETDL has initiated implementation of the Technology Transfer Act by establishing several CRDAs with additional agreements in the process of being formalized. Since ETDL has state-of-the-art on-going R&D both in-house and contractually, we found that industry and academia were eager to work together with us because of our state-of-the-art equipment, skilled technologists and advanced R&D capabilities. Hence ETDL had no trouble putting together a list of at least ten prospective CRDA teams within a matter of a few weeks. Formalizing our planned CRDAs was a bit more slow and difficult. This was due, in part, to the initial lack of regulations, guidelines, and delegated authority, and to manpower shortages in our legal offices. Most of these initial problems are now behind us, since the Army now has interim guidelines, and the authority to sign agreements has been delegated to the Laboratory Directors. Our Laboratory has well established CRDA procedures and has moved forward. A wealth of information has been gained by networking through the Federal Laboratory Consortium (FLC), various legal counsels, other Agencies and through the Army Domestic Technology Transfer Program Manager, Mr. Clifford Lanham, such that the CRDA process has become more of a routine procedure with minimal delays.

ETDL recently transitioned a highly successful Small Business Innovation Research (SBIR) program into a technology transfer program via a CRDA as encouraged by the Army. The SBIR effort resulted in an improved class of ferrite (ceramic magnetic) materials for high frequency switches which utilize these materials for performing circuit functions such as signal switching and electronic antenna scanning in radar and communication systems. This development is already impacting numerous DoD and NASA systems. The follow-on CRDA covers the test and evaluation of these devices under high power operation and is now being carried out in ETDL's high power millimeter wave test and evaluation facility. This effort will aid in the development of devices capable of withstanding the higher power requirements in new radar and satellite communications systems for future military/commercial applications.

ETDL has a number of CRDAs in effect or in various stages of preparation in the following areas of technology:

- Microelectronics
- Nuclear Magnetic Resonance Imaging
- Magnesium Manganese Batteries
- Solid State Materials
- High Frequency Amplifiers

All of these programs are related to ETDL's mission, but also have significant potential for commercial applications. These cooperative efforts typically have from two to eight participants and include such companies and academic institutions as:

- GTE
- NYU School of Medicine
- RAYOVAC Corp.
- University of Virginia
- Research Triangle Institute
- American Cyanamid Co.
- Polytechnic University
- Electric Power Research Institute (EPRI)

Although the CRDA process is becoming more of a routine function, each CRDA is usually significantly different; some have multiple participants, some require payment of costs to the government for use of highly specialized equipment or energy costs, and some CRDAs deal in basic R&D, while others are concerned with test and evaluation.

SUMMARY

In summary, we can say that CRDAs represent to all parties involved, a new and innovative positive method of cperation. Participants are able to leverage their manpower, facilities and financial resources by working together as a team in order to solve common technological problems which they heretofore could not hope to solve individually. Besides the Federal Government, industry and academia benefiting in this manner, the country in general benefits because the technology base grows and high technology is more effectively and efficiently transferred into the commercial sector.

ETDL's SBIR programs pay off

By Richard Stern
and Carol Widmaier

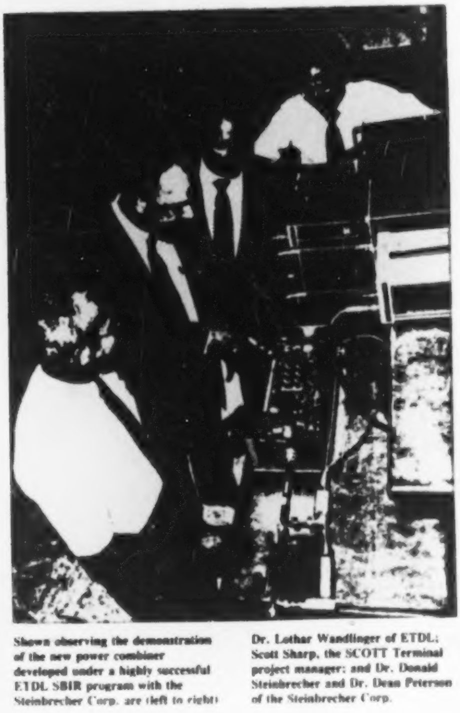
(Editor's note. The Electronics Technology and Devices Laboratory (ETDL), Fort Monmouth, N.J., entered the Small Business Innovation Research (SBIR) arena five years ago with a budget/program of $100,000; today, it boasts a highly successful SBIR program consisting of more than two dozen contracts with a budget in excess of $3 million. The laboratory's first two SBIR programs have now fully completed the SBIR cycle and are already impacting DoD and NASA radar and communications systems for both ground and space applications.)

Technology recently developed under one of ETDL's completed programs is beginning to impact the Army communications satellite effort. This contractual effort was funded through SBIR Phase I and Phase II contracts for the past two-and-a-half years and will provide a significant increase in reliability of communication systems when operating under adverse battlefield conditions such as rain, smoke, fog, or snow by increasing the power available from extremely high frequency (EHF/millimeter-wave) power amplifiers.

Wavelengths in the EHF region are measured in millimeters compared, for example, to the VHF and UHF commercial TV operating regions where wavelengths are measured in meters. The shorter wavelengths at EHF allow substantial reduction in size and weight of electronic components, antennas and associated radar and communication systems for both military and commercial applications.

This effort resulted in an efficient IMPATT-diode power amplifier combiner for communications applications. The SBIR contractor, Steinbrecher, Inc., has demonstrated technology suitable for a key class of Military Stationary Relay (MILSTAR) communications terminals. The technology has increased four times the available output signal power. This solid-state power generation is available in a functional, fieldable form for application in MILSTAR but will have application in other military systems such as millimeter-wave transmitters in smart munitions and imaging radar systems. Measurement, assembly and test procedures have been developed for use with this technology which can be automated and which offer low-cost and reliable solutions for the fielding and maintenance of the millimeter wave power-generating equipment.

High performance millimeter wave switches use new and improved ferrite materials developed by Electromagnetic Sciences, Inc., under an ETDL SBIR program. This effort has now been transitioned into a cooperative R&D agreement under the Technology Transfer Act of 1986.



Shown observing the demonstration of the new power combiner developed under a highly successful ETDL SBIR program with the Steinbrecher Corp. are (left to right) Dr. Lothar Wandlinger of ETDL; Scott Sharp, the SCOTT Terminal project manager; and Dr. Donald Steinbrecher and Dr. Dean Peterson of the Steinbrecher Corp.

Results of this successful SBIR effort have been presented to the Army Single Channel Objective Tactical Terminal (SCOTT) program manager and Magnavox, the prime contractor for the SCOTT ground terminals. SCOTT is the Army version of the MILSTAR program. Magnavox has initiated a program for a producibility demonstration of the millimeter wave transmitter, with Steinbrecher receiving a contract under this program. A Phase III follow-on effort is planned to provide equipment to the federal government utilizing the technology developed under the SBIR Phase II program by Steinbrecher.

The Steinbrecher Corporation is a small, high-tech business located in Woburn, Mass. The company has extensive experience in the design and manufacturer of high-power millimeter wave components and systems and employs 40 people.

ETDL recently transitioned the technology developed under a second highly successful SBIR program into a technology transfer program via a Cooperative Research and Development Agreement (CRDA) as allowed under the Technology Transfer Act of 1986. This SBIR effort resulted in an improved class of ceramic magnetic materials (ferrites, much like "refrigerator" magnets) for millimeter wave devices (i.e., high frequency switches) which utilize these materials for performing circuit functions such as signal switching and electronic antenna scanning in radar and communications systems. This development is already impacting numerous DoD and NASA radar and communications systems.

Participants in the follow-on CRDA are ETDL and Electromagnetic Sciences, Inc., the SBIR contractor. The CRDA [illegible] the test and evaluation of these millimeter wave ferrite materials and associated devices under high power operation and is now being carried out in ETDL's high power millimeter-wave test and evaluation facility located in the newly completed Pulse Power Center.

This effort will aid in the development of devices capable of withstanding the power requirements in new radar and satellite communications systems for future military/commercial applications. Electromagnetic Sciences operated as a small business employing less than 300 people through the initial stages of the SBIR effort, but has since grown to its present capacity of more than 700 people.

ETDL has a number of SBIR programs in progress that will result in new and highly successful technological developments. One such effort is developing a prototype scanning tunneling microscope (STM) with state-of-the-art capabilities for imaging the atomic structure of semiconductor materials and electronic device structures that yield very precise high resolution. This STM would replace more complex and expensive scanning electron microscopes (SEMs) used in quality assurance, manufacturing line testing and inspection and will result in increased semiconductor reliability for military as well as commercial electronic systems.

This Phase II contract is scheduled to be completed at the end of FY89 with commercial versions of the STM unit available in FY90. The significance of this program is that this effort would give the U.S. a decided edge over the Japanese in the development and application of the newly emerging STMs.

Dick Stern, ETDL's SBIR and technology transfer manager, attributes the success of ETDL's SBIR program to several factors. First, the SBIR program is decentralized to the laboratory level allowing project selection by ETDL technical staff. Second, SBIR topics along with Phase I and Phase II proposals are prioritized and carefully screened through several levels of the laboratory chain of command such that a high level of success is insured. A simplified solicitation procedure along with ETDL's prompt execution of SBIR contracts encourages greater participation by small businesses resulting in highly competitive and innovative technical proposals.

Richard A. Stern *received the BS degree in physics from Muhlenberg College in 1960 and the MS degree in electronic engineering from Monmouth College in 1974. He is currently a senior member of the technical staff at the US Army Electronics Technology and Devices Laboratory (ETDL), LABCOM, Ft. Monmouth, NJ, and is responsible for the Laboratory's technology transfer and Small Business Innovation Research (SBIR) programs. His previous professional experience has primarily been in research and development activities concerned with mm-wave transmission lines, antennas and control devices at ETDL. Stern is a member of the IEEE and has authored and co-authored numerous technical papers on ferrite devices, dielectric waveguides and inertialess scanning antennas and holds more than 30 patents. He is also a member of Eta Kappa Nu.*

Mr. **Walgren**. Thank you very much. We appreciate that testimony and we'll come back for a little discussion in a minute. We probably should have put Dr. Brewen on directly after Dr. Princen, since both of you come from northern Illinois, but welcome, Dr. Brewen. We appreciate your being here. Please proceed.

Dr. **Brewen**. Thank you, Mr. Chairman. I appreciate this opportunity to appear before you and your committee and to discuss the Federal Technology Transfer Act of 1986 and particularly the impact it has had and the opportunities it has presented for the formation of a consortium I'm going to describe this morning.

The Biotechnology Research and Development Corporation, which I will refer to hereafter as BRDC, if you don't mind the use of the acronym, is a consortium of seven prominent U.S. corporations with major research and business interests in the biotechnology arena. These companies, very briefly, are the American Cyanamid Company, Amoco Technology Corporation, the Dow Chemical Corporation, ECOGEN Inc., the Hewlett-Packard Company, International Minerals & Chemical Corporation and the Agricultural Research and Development Corporation.

BRDC represents a unique first-of-its-kind organization in the sense that it is the first time that the Federal and a State Government and the private sector have entered into a cooperative research and development endeavor that is mutually funded in terms of supporting dollars for funding of research.

This endeavor was made possible only by the passage of the Federal Technology Transfer Act. This legislation provided the necessary legal direction to finalize a four-year effort to form BRDC. It allows Federal laboratories and the private sector to enter into cooperative research agreements and encourages commercialization through—and I emphasize the word "exclusive"—licensing arrangements for the technologies generated under these agreements.

The U.S. Department of Agriculture and the U.S. Department of Commerce view BRDC as a model program combining the scientific research talents of Federal and State university laboratories with private sector development capabilities.

The BRDC member companies who have both competitive and diverse market interests, join forces in this consortium because they are convinced they can achieve substantial gain by leveraging the research investment in very basic and exploratory research projects.

To address the broad issues of the member companies, BRDC will support basic research that offers flexibility for broad application. In other words, research directed at discovering and inventing new advanced biotechnology production methods and other opportunities. I think the best way to represent what we are engaged in is to read to you our formal mission statement for research.

"BRDC," and I quote now, "is a consortium dedicated to, one, improving the United States technical competitiveness by capitalizing on scientific discoveries made in the Agricultural Research Service Laboratories and universities in the State of Illinois; two, enhancing the competitive and productive research center in the participating ARS laboratories and universities; three, providing the basis for interactive dialogue between the participating research organizations and member companies; four, providing the technology base for shareholder companies to improve their opportunities to manufacture and introduce new biotechnology-related products into the marketplace; and five, assisting in the transfer of this technology base to the member companies.

"The highly diverse nature of the markets addressed by the shareholder companies indicates that the research be generic and basic in order to provide the flexibility for broad application.

"BRDC will initially focus its research activities on developing advanced biotechnology methodology. The emphasis will be placed on discovering—and? developing core technologies in four areas, which are enumerated as, one, new and more efficient transformation and expression systems in both lower and higher organisms, with an emphasis placed on agronomically important plants; two biosensors, three biocatalysis; and four methodologies for developing separations of fermentation products.

"BRDC will actively seek research that is on the cutting edge of the areas of interest and identify brand new and promising ideas to fund. BRDC will do this by encouraging researchers to submit their ideas in all areas of biotechnology. These submissions will be judged on their creativity and perceived opportunity for providing 'breakthrough' concepts. For example, areas of interest to us in the near future are delivery technology and the elucidation of the mechanisms of ligand and cell receptor recognition and binding.

"BRDC will endeavor to identify and support innovative research projects throughout the ARS laboratory network in accordance with the ARS/BRDC Master Research and Development Agreement. As BRDC involves ARS laboratories in other States, it will actively encourage those States and their State institutions to emulate the State of Illinois and become active participants in the program."

Now, the question may be asked, where do we receive our funds? BRDC has been committed $20 million of funding over the next five years. These funds come from the USDA, through the Agricultural Research Service, the State of Illinois and annual contributions from our member companies.

It is our intent to support research principally at the University of Illinois and other public universities in the State of Illinois and at the Northern Regional Research Center in Peoria, Illinois. But we will involve other Agricultural Research Service laboratories and public and private universities in the State of Illinois.

As of this time, we have entered into research and development agreements with two Federal agencies and two public universities in the Illinois State system. These are very broad research agreements. The Federal agencies are the Agricultural Research Service and the National Institute of Standards and Technology, or NIST.

The two universities are the University of Illinois, Champaign/Urbana and Northern Illinois University in De Kalb, Illinois. We are currently negotiating a broad research and development agreement with Southern Illinois University and we have entered into preliminary discussions with Northwestern University and with the Argonne National Laboratory, which is part of the Department of Energy National Laboratory system.

At this moment, we are either actively funding or committed to fund beginning July 1 of this calendar year 29 research projects, totaling nearly $3.5 million per year. All of these projects fall within the four broad areas of interest previously identified and involve each of the above-mentioned institutions with the exception of Northwestern University.

We are funding research not only at the Northern Regional Research Center, but also at the Western Regional Research Center and at the Eastern Regional Research Center.

These research projects are selected by a Scientific Advisory Board, which is composed of representatives from each of our member companies, the Agricultural Research Service and the University of Illinois.

The Scientific Advisory Board judges proposals primarily on technical merit and member company interests, emphasizing innovativeness and the potential as breakthrough concepts. In fact, we have established what I refer to as a seed money fund, which is unique. This fund is to support feasibility studies that would not normally be supported by most Federal granting agencies, because the concept is to support—novel new ideas that require preliminary data for the demonstration of proof of concept. People do not have to come to us with existing data saying, it will work. We say, give us your ideas; we'll support a year's worth of research and if they work, then we'll enter into a major agreement.

It is my personal opinion that the Federal Technology Transfer Act has opened the door to substantially stronger Federal laboratory, academic and private sector cooperation and collaboration. This opinion is based on our experience in our first year of operation. We have found that many of the "pseudo barriers" of intellectual discourse and technical exchange between these three distinct scientific cultural groups have been eliminated by the mere fact that it is now possible for them to work together as a team, striving for a common goal.

Many of our industrial scientists see this as an opportunity to involve themselves in the high-risk basic research that they would not undertake in their own organization; while the academic and Federal scientists now have the opportunity to involve themselves in the commercial development of their basic research successes. We do this by putting work teams, work groups together on a semiannual basis where all scientists discuss their research results, even though they are all under separate agreements.

With that, I conclude my comments and thank you.

[The prepared statement of Dr. Brewen follows:]

STATEMENT OF

DR. J. G. BREWEN

PRESIDENT, BIOTECHNOLOGY RESEARCH AND DEVELOPMENT CORPORATION

PEORIA, ILLINOIS

BEFORE THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

U. S. HOUSE OF REPRESENTATIVES

JUNE 1, 1989

Mr. Chairman, I appreciate the opportunity to appear before your Committee to discuss the Federal Technology Transfer Act of 1986 and its impact.

The Biotechnology Research and Development Corporation (BRDC) is a consortium of seven prominent U.S. corporations with major research and business interests in biotechnology committed to funding and sharing research in the field. The member companies are:

- American Cyanamid Company, Wayne, New Jersey
- Amoco Technology Corporation, Naperville, Illinois
- The Dow Chemical Company, Midland, Michigan
- ECOGEN Inc., Langhorne, Pennsylvania
- Hewlett-Packard Company, Palo Alto, California
- International Minerals & Chemical Corporation, Northbrook, Illinois
- Agricultural Research and Development Corporation (ARDC), Peoria, Illinois

ARDC - a joint venture between CILCORP Ventures Inc. (a venture-capital subsidiary of CILCORP Inc.) and The Economic Development Council for the Peoria Area - envisioned and spear headed development of BRDC. Our offices are in the U.S. Department of Agriculture's (USDA) Northern Regional Research Center (NRRC) in Peoria, Illinois.

This is the first time federal and state governments and the private sector have come together in a cooperative research and development endeavor, made possible by the Federal Technology Transfer Act (signed into law by President Reagan in October, 1986). U.S. Representative Robert Michel (R-IL), House Republican Leader, and U.S. Senator Robert Dole (R-KS), then Senate Majority Leader, sponsored the act and guided its passage.

The landmark legislation provided the necessary legal direction to finalize the four-year effort to form BRDC. It allows federal laboratories and the private sector to enter cooperative research agreements, and encourages commercialization through exclusive licensing arrangements for technologies these agreements generate.

The USDA and U.S. Department of Commerce view it as a model program combining the scientific-research talents of federal and state university laboratories with private sector development capabilities. The BRDC member companies, who have competitive and diverse market interest, joined forces because they are convinced they can achieve substantial gain by leveraging their research investment in basic and exploratory projects.

To address these interest, BRDC will support basic research that offers flexibility for broad application, i.e., research directed at discovering and inventing new, advanced biotechnology-production methods. This effort is best represented by BRDC's Statement of Research Mission, which follows.

> "The Biotechnology Research and Development Corporation (BRDC) is a consortium dedicated to: 1) improving the United States' technical competitiveness by capitalizing on scientific discoveries made in the Agricultural Research Service's (ARS) laboratories and universities in the state of Illinois; 2) enhancing the competitive and productive research center in the participating ARS laboratories and universities; 3) providing the basis for interactive dialogue between the participating research organizations and member companies; 4) providing the technology base for its shareholder companies to improve their opportunities to manufacture and introduce new biotechnology related products into the marketplace; and 5) assisting in the transfer of this technology base to the member companies. The highly diverse nature of the markets addressed by the shareholder companies indicates that the research be generic and basic in order to provide the flexibility for broad application.
>
> "BRDC will initially focus its research activities on developing advanced biotechnology methods. The emphasis will be placed on discovering the developing core technologies in the four areas of 1) new and more efficient transformation and expression systems in both prokaryotic and eukaryotic organisms, with an emphasis placed on agronomically important plants; 2) real-time sensors; 3) biocatalytic conversions; and 4) post-fermentation separations. BRDC will actively seek research that is on the cutting edge of the areas of

> interest and identify brand new and promising ideas to fund. BRDC will do this by encouraging researchers to submit their ideas in all areas of biotechnology. These submissions will be judged on their creativity and perceived opportunity for providing "breakthrough" concepts. For example, areas of interest to us in the near future are delivery technology and the elucidation of the mechanisms of ligand and cell receptor recognition and binding.
>
> "BRDC will endeavor to identify, and support, innovative research projects throughout the ARS laboratory network in accordance with the ARS/BRDC Master Research and Development Agreement. As BRDC involves ARS laboratories in other states it will actively encourage those states and their state institutions to emulate the state of Illinois and become active participants in the program."

BRDC funds ($20 million during the next five years) come from the USDA/ARS, the state of Illinois and annual contributions from our member companies. We will support research principally at the University of Illinois and the NRRC, but will also involve other ARS laboratories and public and private universities in the state of Illinois.

As of this date BRDC has entered into research and development agreements with two federal agencies and two Illinois state universities. These are the ARS and National Institute of Standards and Technology (NIST) and the University of Illinois and Northern Illinois University. An agreement is currently being negotiated with Southern Illinois University and preliminary discussions are being held with Northwestern University and Argonne National Laboratory.

Presently, BRDC is either actively funding, or committed to fund beginning July 1, 1989, twenty-nine research projects totaling almost $3.5 million per year. All of these projects fall within the four broad areas of interest previously mentioned and involve each of the above mentioned institutions except Northwestern University.

We select research projects through our Scientific Advisory Board (SAB), composed of representatives from each of our member companies, ARS and the University of Illinois. The SAB judges proposals primarily on technical merit and member company interest, emphasizing innovativeness and potential as breakthrough concepts. In fact, we have established a "seed money" fund to support feasibility studies that would not normally be supported by most federal granting agencies. This concept is to support apparently novel ideas that require preliminary data to establish the proof of concept.

It is my opinion that the Federal Technology Transfer Act has opened the door to substantially stronger federal laboratory, academic and private sector cooperation and collaboration. This opinion is based on our experience in our first year of operation. We have found that many of the "pseudo-barriers" of intellectual discourse and technical exchange between these three scientific "cultural groups" have been eliminated by the mere fact that it is now possible for them to work together as a team. Many of our industrial scientists see this as an opportunity to involve themselves in the high risk basic research that they would not undertake in their own organization while the academic and federal scientists now have the opportunity to involve themselves in the commercial development of their basic research successes.

Mr. **Walgren**. Thank you, Dr. Brewen. We appreciate it.

Dr. Adler, welcome.

Dr. **Adler**. Mr. Chairman, members of the subcommittee, on behalf of the Public Health Service, we thank you for this opportunity to testify on our implementation of the Federal Technology Transfer Act.

Based on our experience to date, the FTTA has provided a very effective and increasingly utilized mechanism for tranferring the results of our laboratory research to the commercial sector. Moreover, these external collaborations have also enhanced our own intramural research capabilities, not only through access to corporate scientists and their facilities, but also in providing access to our own investigators to essential biological research materials that might otherwise be unavailable to us without the promise of invention rights back to the companies who are the source of these research materials.

If I might direct your attention to the chart on page 17 of my testimony, this shows a steadily increasing rate of CRADA approval within the Public Health Service agencies. At the present time, about 100 CRADAs have been signed. We have about 80 others under various states of negotiation. The NIH itself is a signatory to about 80 percent of the CRADAs. However, all of the Public Health Service agencies participate in cooperative projects.

Within the Public Health Service four agencies conduct biomedical or behavioral research, and these include the National Institutes of Health, the Alcohol, Drug Abuse and Mental Health Administration, the Centers for Disease Control, and the Food and Drug Administration. My testimony this morning will focus on NIH and ADAMHA, which have joined together to administer implementation of the FTTA through the NIH/ADAMHA Patent Policy Board, on which the CDC, FDA and Office of the Assistant Secretary for Health participate.

Authority under the FTTA was delegated to the Public Health Service by the Secretary of the Department. Substantially all authority was redelegated to agency heads. Within the Public Health Service, the Deputy Assistant Secretary for Health is the focal point for resolving issues that cross agency borders and for coordinating technology transfer activities within the Public Health Service. And a technology management advisory board assists the Deputy Assistant Secretary for Health in developing policy guidelines and evaluating our implementation of the Act.

The technology management advisory board developed fair access guidelines that I would like to submit for the record, with your permission.

Mr. **Walgren**. Without objection.

[The guidelines follow:]

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Office of the Assistant Secretary
for Health
Washington DC 20201

FEB - 1 1989

FROM: Assistant Secretary for Health

SUBJECT: PHS Policy for Ensuring Fairness of Access in Cooperative Research and Development Agreements

TO: PHS Agency Heads

Attached is a copy of the PHS Policy for Ensuring Fairness of Access for use in developing Cooperative Research and Development Agreements (CRADAS) negotiated pursuant to the Federal Technology Transfer Act of 1986.

This policy was adopted by the PHS Technology Management Advisory Board. I am approving and issuing it as PHS policy effective this date.

Robert E. Windom, M. D.

Attachment

SUBJECT: PHS POLICY FOR ENSURING FAIRNESS OF ACCESS IN COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS

I. PURPOSE

This document establishes guidelines for PHS Federal Laboratories to ensure fairness in the process of initiating and developing a Cooperative Research and Development Agreement (CRADA).

II. BACKGROUND

The purpose of the Federal Technology Transfer Act of 1986 is to facilitate the transfer of commercially useful technologies from the Federal Laboratories into the private sector through collaborations under CRADAs. These agreements are intended to increase research and development interactions between Federal Laboratories and industry through joint participation in collaborative projects, including the provision of personnel, services and property. In addition, industry, but not the Federal Government, may provide funding.

The legislation gives the Federal Laboratories authority to negotiate terms and conditions with a wide range of parties. Although the legislation does not specify that CRADAs must be competed, the law does require that consideration shall be given to small business firms and consortia involving small business firms, and preference be given to business units located in the United States which agree that products resulting from the CRADAs shall be manufactured substantially in the United States.

Since procurement rules do not apply to CRADAs, the Federal Laboratories have considerable flexibility in determining how and with whom to enter into collaborations. However, the manner in which collaborators or sponsors are selected is important to both the importance and reality of fairness. The question of fairness will be viewed as particularly important by others who view themselves as qualified when the private sector partner selected stands to benefit substantially as a result of the collaboration.

Many legitimate collaborations between government and industry scientists have grown from informal exchanges between them. The policy described is intended to assist in allowing participation in CRADAs by a wide range of organizations, many of which do not have established relationships with PHS scientists.

III. APPLICABILITY

Four PHS agencies operate research laboratories which are affected by the Act: National Institutes of Health; Alcohol, Drug Abuse and Mental Health Administration; Centers for Disease Control; and Food and Drug Administration. For the purposes of this policy, each of these agencies is considered a PHS Federal Laboratory.

IV. POLICY

"The policy of the PHS is to facilitate the development of CRADAs with the private sector through a process that will ensure fairness and implement the preferences established by the Federal Technology Transfer Act."

V. GUIDELINES

This section establishes guidelines on the activities that PHS Federal Laboratories are encouraged to engage in, but are not limited to, to ensure that the opportunity to participate in a CRADA is given to all potentially interested organizations.

A. PUBLIC NOTIFICATION ACTIVITIES

The various public notification activities are described below.

1. Routine Announcements

Each PHS Federal Laboratory should implement a process for periodically informing outside parties of available collaborative opportunities and for encouraging access to the Federal Laboratories by industry. Federal Laboratories are encouraged to use at least one of the following activities on an annual basis:

(a) General Announcements. Publish an announcement which generally outlines the types of research opportunities available for collaboration and identifies a central point for interested parties to contact. General announcements can be made through the *Federal Register*; *Commerce Business Daily*; scientific, professional, and trade journals; or association publications.

(b) Industry Collaboration Forums. Conduct or participate in an Industry Collaboration Forum to bring together interested Federal Laboratory scientists and private sector company or other outside representatives.

(c) Directory Listing. If financially feasible, develop a directory listing of potential Federal Laboratory scientist collaborators, areas of research interests, and Government-owned patents available for licensing. This information would be provided at cost to all interested parties upon request. The general announcement could indicate that this directory is available.

Once an area of research that the Federal Laboratory is interested in collaborating on is included in a routine announcement, no additional public notification is needed before entering into a CRADA.

2. Special Announcements

There are three conditions that would indicate the possible need for a special announcement before the Federal Laboratory enters into a CRADA:

(a) In the process of negotiating a CRADA, it may be determined that the collaboration goes beyond the capabilities and/or resources of the Federal Laboratory or the private sector organization and requires additional fields of expertise over and above that of the involved scientists. On such collaborative efforts, if there is no known potential collaborator, a special announcement should be made to inform all other interested parties that an additional sponsor or collaborator is needed.

(b) When a Federal Laboratory initiates a major research effort and seeks collaborations with private sector organizations in an area that has not been a topic of a currently pertinent announcement.

(c) When a substantial number of private sector organizations are likely to be interested in participating because of their qualifications, or because they have ongoing, publicly-known, closely-related activities.

Special announcements would describe specifically the purpose of the collaboration and would provide interested organizations the opportunity to submit proposals. Announcements could be made in the Federal Register; Commerce Business Daily; scientific, professional, and trade journals; association publications; press releases; etc.

Examples of general guidance on when public notification activities could be initiated by the Federal Laboratory are included in Attachment A.

B. TRAINING PROGRAM

Each PHS Federal Laboratory should establish an ongoing training and education program to ensure that Federal Laboratory scientists are informed about the Federal Technology Transfer Act and are aware of the business considerations outlined in the law.

Since the Federal Technology Transfer Act permits and encourages new types of relationships to bridge industry and government research, the training program should also include guidance on acceptable relationships which might otherwise be prohibited under conflict of interest regulations.

C. INTERNAL REVIEW PROCESS

Each PHS Federal Laboratory should establish an internal review process at a level above the bench scientist (i.e., institute, bureau, division level). This process should ensure that CRADAs are reviewed not only for the value of the technology, but also for the appropriateness of the selected private sector collaborator.

(1) Documentation. CRADA documentation should include a brief statement indicating why the particular outside collaborator was selected (i.e., special expertise, unique ideas, or other factors). This information will provide an explanation of the actions of the Federal Laboratory which led to the selection of the outside collaborator.

(2) Internal Review. The review should be conducted before the CRADA is transmitted to the agency level for review. The documentation on the selection of the collaborator should provide information on the appropriateness of the selection.

Approved: ______________________ 2-1-89
Robert E. Windom, M.D. Date

EXAMPLES OF CONDITIONS WHICH MAY EXIST PRELIMINARY TO THE COLLABORATION	TYPES OF PUBLIC NOTIFICATION ACTIVITIES			
	GENERAL ANNOUNCEMENTS	INDUSTRY FORUMS	DIRECTORY LISTING	SPECIAL ANNOUNCEMENTS
No proprietary rights exist. Area of research is of interest to Government and Government will grant Industry exclusive marketing rights.	Yes	Yes	Yes	No
No proprietary rights exist. Government initiates a major collaboration which will include granting exclusive marketing rights. However, there is a need for an additional collaborator. (Collaboration is sought in an area that has not been a topic of a currently pertinent announcement, or a number of organizations are likely to be interested in participating.)	Yes	Yes	Yes	Yes
Industry holds proprietary rights, wants Government to provide resources to further develop the product, and wants exclusive marketing rights.	No	No	No	No
Industry holds proprietary rights, wants Government to provide resources for a major collaboration, and wants exclusive marketing rights. However, there is a need for an additional collaborator. (Collaboration is sought in an area that has not been a topic of a currently pertinent announcement, or a number of organizations are likely to be interested in participating.)	No	No	No	Yes

Dr. **Adler**. I would like at this point just to focus, if I may, on the highlights of the written testimony, to skip the points that are cumulative to comments offered by my colleagues.

We have the Patent Policy Board, which I mentioned. This makes recommendations on policy matters. It reviews and approves model agreements, several of which I have submitted earlier along with the written testimony for the record. Dr. Philip Chen, who is the NIH Associate Director for Intramural Affairs, chairs the Patent Policy Board, and its membership is drawn primarily from senior level administrators and scientists at NIH and ADAMHA.

The NIH and ADAMHA are comprised of a number of different institutes, including the National Cancer Institute, which was mentioned earlier as a large source of Public Health Service royalties.

I would like to mention one additional component of our implementing team at NIH and ADAMHA, and these are the technology development coordinators designated within each of the various institutes to serve as the primary contact for companies or universities that wish to enter into CRADAs. These technology development coordinators meet together as a subcommittee with myself and members of my office to share common experiences, to discuss the stages of implementation of various forms and policies, and to help each of us avoid reinventing the wheel on particular issues. And the Centers for Disease Control and FDA also participate at this committee level.

The Office of Invention Development, which I direct, is located at the NIH. It coordinates and champions technology transfer activities at NIH and ADAMHA. We take the lead in developing licensing strategies for the inventions which result from intramural research, and we serve as the primary conduit of information and advice and instructions between NIH and ADAMHA and the Office of Federal Patent Licensing at the NTIS.

Some of our activities have included the drafting of a model CRADA, a policy statement on cooperative research and intellectual property licensing, and a model materials transfer agreement.

The terms of these agreements are negotiated on a case-by-case basis with industry, but our development and use of the model agreement has greatly expedited the internal approval time. It now takes less than two months, in most cases, once the basic research project of a CRADA has been developed, to gain whatever administrative review and approvals are necessary.

The CRADA licensing policy statement, I believe, is the central component of our FTTA implementation. It affirms the commitment at NIH and ADAMHA to transfer technology within an overall framework that promotes the free exchange of ideas and information, preserves the freedom of our investigators to publish the results of their research, and it attempts to safeguard the traditional openness, collegiality, as well as the public confidence in the Public Health Service research programs.

The various provisions of this policy statement, which I submitted earlier for the record along with the testimony, are significant because they balance a number of what appear to be competing policy requirements. For example, the missions of these agencies are to conduct basic research in unexplored areas of knowledge. Yet we actively pursue technology transfer and CRADAs. In many cases we find that what is basic research for us has clinical promise or commercial promise, so it is commercial research on the part of our collaborators under a CRADA and in many cases still remains basic research for us.

Briefly, with respect to the CRADA process itself, we treat CRADAs as research projects rather than as commercial ventures. As the gentleman from GAO noted a little while ago, most of the royalties have been earned on intramural inventions which were developed prior to enactment of the FTTA. It seems to be the nature of biomedical research that inventions come two to three years down the road in a research project, and, in fact, I'm aware of about eight to ten inventions that have been made collaboratively under CRADAs. We are in the process of negotiating license agreements for those inventions at the present time.

We are also developing a model biotechnology and pharmaceutical license agreement to use in negotiations with industry for both intramural inventions as well as inventions resulting from CRADA research. All of the agreements are CRADA. The model material transfer agreement, the model license agreement, have been and will be developed with consultation from industry, from the pharmaceutical and biotechnology trade associations, as well as the university licensing offices, and their input is reflected in the current versions of these documents.

As to distribution of royalties, at the present time the Public Health Service brings in slightly over $5 million, as of the last fiscal year, in royalties. About $3.5 million of this total results primarily from an AIDS diagnostic test kit developed by Dr. Gallo's lab. There has been an increasing level of patent activity from intramural research. Two years ago we filed approximately 80 to 90 patent applications. This fiscal year we forecast over 200. So that in the spirit of technology transfer, our scientists are taking a heightened interest in the filing of patent applications. We expect the royalty base to broaden a little bit beyond AIDS test kits. The royalty stream we expect to increase in coming years, also, as research results from CRADA projects are brought under licensing programs.

The technology management advisory board, which I mentioned earlier, helped develop Public Health Service guidelines on fair access to Government laboratories, and we take into account a number of factors. CRADAs, of course, are not subject to the normal procurement competition provisions. However, in cases where a substantial number of companies are likely to be interested, where a particular project lies in a previously unannounced area of research, or where the commercialization potential seems rather large relative to basic research aspects, we seek either competitively or through other processes collaborators for CRADAs who have both scientific and commercialization abilities.

As to public access, we host an annual forum that brings together scientists at NIH and ADAMHA interested in collaborating, along with industry research directors and scientists who might have an interest in some sort of collaborative project. We publish also an annual directory, called the CRISP Intramural Research Index, which lists all of our intramural research projects.

We also encourage scientists, as appropriate, to enter into CRADAs with more than one company. An example of that is Dr. Gallo's lab, which has one CRADA signed, several others close to final stages of negotiation, and others for different aspects of AIDS research under other stages of negotiation.

We benefit also within the Public Health Service from the existence of a very entrepreneurial biotechnology industry, which helps. In many cases, we don't need to seek collaborators for all projects. Many times, projects are proposed to us by various companies, although it appears that many of the CRADAs have developed from normal scientist to scientist contacts, meetings at conferences, and other places.

We have held a retreat on conflicts of interest last December, and are in the process of working with several other agencies to evaluate and develop specific guidelines for the types of conflicts that may arise from collaborations under such projects.

Finally, I would like to focus on three specific issues that have arisen in the course of our implementation of the FTTA. First is the copyright and licensing of software. Just to give you an example of the types of software we develop, these include very sophisticated molecular modeling programs, as well as expert diagnostic systems that might have great commercial utility in the clinical setting. At the present time, the inability of Government employees to copyright software tends to make collaborative development and licensing of software less attractive to the commercial sector.

Secondly, as to the licensing of unpatented technology, the Public Health Service laboratories develop a great deal of research material that for various reasons may not be patentable or likely to result in an issued patent.

Because the FTTA appears to authorize only the licensing of intellectual property rights, the NIH/ADAMHA patent policy board has not permitted the licensing of technology generally for such research materials. Thus, patentable research material is not commercially licensed to industry, although most universities do actively license such research material.

Finally, because the Department of Health and Human Services has a dual role in funding research, as well as subsidizing and, in some cases, providing medical care, we have an interest that there be a reasonable relationship between the pricing of licensed products and the public health and safety needs. Accordingly, in our CRADAs and under our CRADA licensing policy statement, we require that this relationship be supported by reasonable evidence.

To conclude, based on our experiences to date, the FTTA is providing a very exciting and, I believe, very appropriate mechanism for transferring Government technology to the commercial sector. It has also enhanced significantly the quality and quantity of our own research programs.

I thank you for this opportunity to testify.

[The prepared statement of Dr. Adler, with attachments, follow:]

For Release Upon Delivery

Testimony by

Reid G. Adler, J.D.
Director, Office of Invention Development

National Institutes of Health
Public Health Service
Department of Health and Human Services

On the Implementation of the Federal Technology Transfer Act of 1986

Before the

Subcommittee on Science, Research and Technology

Committee on Science, Space and Technology

United States House of Representatives

June 1, 1989

Mr. Chairman and Members of the Subcommittee:

The National Institutes of Health (NIH), on behalf of the Public Health Service (PHS), appreciates this opportunity to present testimony on our implementation of the Federal Technology Transfer Act of 1986 (FTTA). I will be discussing the organizational structure, and administrative mechanisms and policy guidelines developed to promote and manage cooperative research and development. Additionally, my testimony will cover the distribution of patent licensing royalties as well as some of the issues that have emerged during these early years in the implementation of the FTTA, such as fair access, conflicts of interest, licensing and the copyrighting of software.

Based on our experience to date, the FTTA has provided an effective and increasingly used mechanism for transferring the results of laboratory research to the commercial sector. Moreover, external collaborations have enhanced our own intramural research capabilities through access to corporate scientists, research programs, and, in some cases, essential biological research materials that would otherwise be unavailable to our investigators. Opportunities to join in cooperative research and development projects with Government scientists and engineers have been of great interest to universities and various biomedical industries. From the signing of the first Cooperative Research and Development Agreement (CRADA) on December 1, 1986, about 100 PHS CRADAs have been signed and some 80 more are under negotiation. The NIH is a signatory party in about 80 percent of these totals. The chart in **Appendix A** shows a dramatically increasing rate of approval for CRADAs signed by PHS agencies overall.

The Public Health Service:

The PHS agencies that conduct biomedical research as part of their mission are the NIH, the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA), the Centers for Disease Control (CDC), and the Food and Drug Administration (FDA). Each of these agencies has established an internal mechanism to implement the FTTA. The focus of my testimony will be on NIH and ADAMHA which have joined together in implementing the FTTA through the NIH/ADAMHA Patent Policy Board, discussed below, on which the CDC, FDA and the Office of the Assistant Secretary for Health participate as observers.

Full authority under the FTTA was delegated to the PHS by the DHHS, and substantially all authority was redelegated to Agency Heads. However, the Deputy Assistant Secretary for Health has been designated as the focal point for technology transfer activities and for the resolution of issues that cross over agency boundaries. To assist in these activities, former Assistant Secretary for Health Robert E. Windom established the PHS Technology Management Advisory Board (TMAB) to coordinate FTTA activities among the PHS agencies. The TMAB, comprised of PHS Deputy Agency Heads and senior agency officials responsible for technology transfer, is chaired by the Deputy Assistant Secretary for Health.

In 1988, the TMAB focused primarily on two issues: (1) devising PHS policies to ensure fair access to cooperative research and development opportunities; and

(2) determining whether guidelines should be established to ensure fair pricing of products developed under CRADAs. The "fair access" guidelines were issued in December, 1988 and have been submitted for the record. The TMAB also approved the concept of encouraging the negotiation of some type of equitable pricing assurance in CRADAs when exclusive commercialization license rights are granted to collaborating partners in exchange for their participation in product development.

The NIH/ADAMHA Patent Policy Board:

The NIH/ADAMHA Patent Policy Board was established by the Director of the NIH and the Administrator of ADAMHA to make recommendations on policy and model agreements, and to develop the administrative framework needed to implement the patent and CRADA process at the NIH/ADAMHA. The Board is chaired by Dr. Philip S. Chen, Jr., NIH Associate Director for Intramural Affairs; its membership is drawn from senior level administrators and scientists at the NIH and ADAMHA. The CDC, FDA and the Office of the Assistant Secretary for Health are represented at the Board meetings. The CDC and FDA are moving toward adopting policies under the FTTA similar to those of the NIH/ADAMHA.

The Board has established several working subcommittees to address specific issues and tasks that have emerged from NIH/ADAMHA efforts to implement the FTTA:

- The CRADA Subcommittee reviews all CRADAs involving exclusive patent license rights, and assesses their acceptability and appropriateness. This

Subcommittee also makes policy recommendations regarding CRADAs to the Patent Policy Board.

- The Royalty Distribution Subcommittee makes policy recommendations on royalty distribution to the Board, as well as on the uses of royalty income as incentives for additional technology transfer.
- The Data Systems Subcommittee evaluates the Board's data management requirements, and vendor-supplied software for purposes of tracking and docketing PHS patent application activities, CRADAs and licensing matters.
- The Training Subcommittee develops materials and programs to educate the NIH/ADAMHA community on the patent process and all aspects of the FTTA. The Subcommittee also conducts training sessions to convey important information relating to the FTTA and to teach employees how to use the evolving NIH/ADAMHA procedures to facilitate technology transfer.
- The BID Technology Development Coordinators Subcommittee [BID refers to the various "Bureaus, Institutes and Divisions" of the NIH and ADAMHA] meets monthly with the Director of the Office of Invention Development to discuss procedures for implementing the FTTA and to share experiences. These Coordinators are responsible for the day-to-day activities under the FTTA within their respective BIDs.

The Office of Invention Development:

The Office of Invention Development (OID), located at the NIH, centrally coordinates and champions technology transfer activities at the NIH and ADAMHA. In general, the major responsibilities of the OID include the development of policy and procedures, including those to implement Patent Policy Board decisions and policies, and the drafting of model forms and agreements. The OID takes the lead in developing licensing strategies for NIH/ADAMHA intramural inventions. In conjunction with the Training Subcommittee, the OID plays an active role in training and educational activities. The OID also serves as the principal conduit of information, advice and instructions between the NIH/ADAMHA and the Office of Federal Patent Licensing of the National Technical Information Service (NTIS).

Specifically, the OID has coordinated the drafting of a model Cooperative Research and Development Agreement (CRADA), submitted for the record and discussed below, that serves as the starting point for negotiating agreements under the FTTA, model Material Transfer Agreement (MTA) now awaiting NIH and ADAMHA Agency Heads' approvals, and a policy statement on CRADAs and patent licensing, also submitted for the record and discussed below. In early draft versions, these documents were circulated for comment to pharmaceutical and biotechnology trade associations and corporations and to several university licensing offices, and were revised to reflect many of their suggestions.

The OID presently is coordinating the acquisition of a data management system to serve as the central information repository for all PHS invention reports, the status of U.S. and foreign patent applications, CRADAs, MTAs, licenses and royalties. The OID also is developing a database of industry contacts and their areas of research interest, together with NIH scientists interested in collaborations and their areas of research interest. This database will facilitate solicitation of licensing interest by the business sector in patent applications resulting from our intramural research programs as well as participation by the private sector in specific cooperative research and development projects.

NIH/ADAMHA technology management teams, with the sole charge of developing licensing strategies for inventions on a case-by-case basis, will begin meeting this month. These teams will consist of the OID Director, BID Technology Development Coordinators, OID staff, Patent Branch attorneys, involved inventors and NTIS licensing specialists. The OID staff itself is a mix of newly-hired technology management and market evaluation specialists along with career government employees.

The NIH/ADAMHA CRADA and Licensing Policy Statement:

In pursuing their agencies' mission, the NIH and ADAMHA have developed a "Policy Statement on Cooperative Research and Development Agreements and Intellectual Property Licensing" ("CRADA/Licensing Policy Statement"). This Policy Statement (submitted for the record) defines the agencies' mission in terms of conducting basic biomedical and behavioral research. It affirms our commitment to transfer technology within an overall framework that promotes the free exchange of ideas and information by, for example, preserving the freedom of our investigators to publish the results of their research, and attempts to safeguard the collegiality and integrity of, as well as public confidence in, the NIH/ADAMHA research programs.

Other sections of the CRADA/Licensing Policy Statement treat questions of "fair access" by outside companies to the NIH/ADAMHA laboratories, and the handling of confidential or proprietary information. Also covered are our intentions to grant royalty-bearing exclusive and nonexclusive commercialization licenses in order to stimulate commercial development, and to grant nonexclusive, royalty-free licenses for research purposes in order to stimulate further basic research. These provisions are significant because they balance a number of competing policy requirements. The CRADA/Licensing Policy Statement applies to inventions made through our intramural research programs as well as through cooperative research and development projects under the FTTA.

The CRADA Process:

The NIH/ADAMHA model CRADA contains standardized legal boilerplate with appendices that define a particular collaboration. While NIH/ADAMHA are willing to consider requests from potential collaborators for modifications on a case-by-case basis, in most instances the standardized language has proven to be acceptable. Because NIH/ADAMHA research is characterized as "basic" research, for the most part, CRADAs are treated as proposals for research projects rather than as commercial ventures.

The essence of a cooperative research and development project is its "Research Plan" which forms Appendix B to NIH/ADAMHA CRADAs. Once the Research Plan has been agreed to by the NIH/ADAMHA investigator (and his or her Laboratory Chief) along with the collaborating investigator, approval of the CRADA is simple and fairly rapid. The CRADA first must be approved by the BID Scientific Director to ensure that the proposed project is consistent with the BID mission and overall research efforts. The CRADA is next cleared within the Office of General Counsel by the NIH or ADAMHA Legal Adviser, who looks primarily at any negotiated changes to the legal boilerplate set forth in Appendix D to the CRADA.

The CRADA Subcommittee next reviews the CRADA, as discussed above and, if approved, the CRADA is sent to the Director of NIH or Administrator of ADAMHA, respectively, for disapproval or modification. Finally, the CRADA is returned to the respective BID Director for signing and then forwarded to the collaborator for signature. Each BID has designated a "BID Technology Development Coordinator," mentioned above, who plays an active role in this overall process, from negotiating agreements through obtaining final signatures in order to execute officially the final CRADA. Use of the model CRADA has reduced significantly both negotiation and review time for CRADAs to less than two months, and has made it possible for scientists to communicate NIH/ADAMHA policies to potential collaborators more readily. An identification of PHS CRADAs is presented in **Appendix B** to this testimony.

Treatment of Invention Rights:

Under their CRADA/Licensing Policy Statement, NIH and ADAMHA retain title to their inventions, but do consider requests for nonexclusive or exclusive commercialization licenses to intellectual property rights in patent applications and patents. The model CRADA provides an option to the collaborator to negotiate, in good faith, the terms of an exclusive or nonexclusive commercialization license on terms that reflect several factors, including the relative contributions of the CRADA parties to the invention and the costs of subsequent research and development needed to bring an invention to the marketplace.

The number of intramural patent applications filed per year by the PHS has increased over the past few years, reflecting an increased awareness of the importance of patenting. For example, about 90 patent applications were filed in fiscal year 1987, about 150 in fiscal year 1988, and we anticipate the filing of over 200 patent applications in fiscal year 1989. About ten inventions have been made under various NIH/ADAMHA CRADAs, and patent applications have been filed on these inventions or are being drafted. The Patent Branch of the Office of General Counsel (DHHS) located at the NIH provides domestic patent prosecution services to all PHS agencies.

The OID is presently drafting a model commercialization license agreement to serve as the starting point for negotiations regarding invention rights stemming from

CRADAs or from intramural research programs. This agreement will be developed in consultation with the NTIS as well as industry and academia.

Distribution of Royalties:

Under NIH/ADAMHA policy, inventors share 25 percent of the first $50,000 of cumulative gross royalties on a licensed invention, 20 percent of the second $50,000 and 15 percent of the royalty income over $100,000. A portion of the royalties are used to pay for NTIS licensing services and to support the staff of the OID. Remaining royalty funds are distributed to the BIDs of the inventors named on a given patent application or patent. At the present time, about 140 PHS patent(s) and patent applications have been licensed through the NTIS and earn royalties.

Total royalty income from patent licensing was $5,164,019 in fiscal year 1988, of which $3,399,322 was paid to the French-American AIDS Foundation pursuant to an international agreement signed in 1987. Much of these funds, however, are returned to the NIH as a grant from the Foundation to support AIDS-related research. Most of the remaining $1,988,893 in royalties in fiscal year 1988 was earned on a few patents of the National Cancer Institute.

Fair Access:

As required by the FTTA and the PHS fair access guidelines, mentioned above, NIH/ADAMHA give special consideration to entering into CRADAs with small business firms and preference to businesses located in the United States that agree to manufacture substantially in the United States. Because of the large number of research projects underway in the laboratories of the PHS and the relatively small number of CRADAs in effect or under negotiation, only in rare instances have multiple companies proposed an identical research effort. In some cases, however, comparable research has been undertaken by different companies under CRADAs with laboratories in different BIDs. In other cases, such as where a substantial number of companies are likely to be interested or where the project lies in a previously unannounced research area, NIH/ADAMHA have sought or plan to seek collaborators competitively. For some cooperative projects, where the development and commercialization potential is more immediate relative to its basic research aspects, NIH/ADAMHA considers and may seek (through Federal Register notice) a collaborator(s) that has both the requisite scientific expertise and commercialization capability.

Many of the existing NIH/ADAMHA CRADAs appear to have resulted from the usual scientist-to-scientist contacts that occur at conferences and other places. Additionally, NIH/ADAMHA have several formal mechanisms in place to notify the business and scientific communities of ongoing projects and research opportunities. For example, the NIH/ADAMHA publishes an annual directory (the "CRISP Intramural Research Index") of all intramural projects, cross-referenced by key word and by principal investigator. Additionally, last October NIH/ADAMHA hosted the first annual NIH/ADAMHA-Industry Collaboration Forum. Over 300 industry representatives attended the Forum and inspected posters of NIH/ADAMHA investigators who were seeking corporate collaborators. Our next "Forum" is scheduled for October 3, 1989.

Fair access to NIH/ADAMHA research collaborations is also reflected in our practice of encouraging multiple CRADAs with a given laboratory. For example, Dr. Gallo's AIDS research laboratory has one CRADA in effect, another expected shortly to be finalized and three other CRADAs in various stages of negotiation, each with a different company.

The Federal Laboratory Consortium:

NIH/ADAMHA Patent Policy Board representatives attend Federal Laboratory Consortium meetings at the national and regional level. For example, Dr. Chen participated in a panel discussion at the Northeast Region regional meeting at Mystic, Connecticut on November 17, 1988. Because of the specialized nature of our research, our extensive grant funding of university research and our traditional interactions with the pharmaceutical and biotechnology industries, NIH/ADAMHA are already well connected with potential FTTA collaborators and potential licensees.

Conflicts of Interest:

The PHS recognizes that collaborations with industry and the payment of royalties create a potential for conflicts of interest. The PHS fair access policy and the NIH/ADAMHA policy of not negotiating royalty rates in advance under CRADAs helps to minimize some conflicts. NIH/ADAMHA scientists and engineers are permitted to consult for industry on outside work time, as is commonly permitted in academia. Because a CRADA represents official Government work, investigators are not permitted to earn a consulting fee for their efforts under a CRADA. As a result, investigators, in some cases, might be faced with a choice between continuing a paid consultantship or moving into a more extensive cooperative research project under a CRADA.

In order to evaluate and treat the resultant potential for conflicts of interest, the NIH/ADAMHA Patent Policy Board held a "Retreat on Conflict of Interest in Collaborations with Industry" last December that was attended by senior scientists and administrators of the PHS as well as representatives from several corporations, foundations and universities. A summary of this retreat has been disseminated by the Board, and is serving as the basis for an expanded analysis of conflicts of interest being conducted by the OID.

Many Government agencies also are developing guidelines on conflicts of interest affecting intramural research. Dr. Chen, the Chairman of the NIH/ADAMHA Patent Policy Board, participated in the recent workshop on government-industry collaboration in biomedical research and education hosted by the Institute of Medicine. I will be attending a similar, informal program this month hosted by the American Association for the Advancement of Science. Several other Government laboratories have expressed an interest in joining with the OID this summer to analyze conflicts of interest raised by collaborations under the FTTA and the licensing of patents under

Federal patent law. The OID staff continues to meet regularly with industry and trade association representatives to discuss the treatment of particular conflict of interest situations. Such meetings provide NIH/ADAMHA with the opportunity to resolve individual cases while developing an experience base that will ultimately be reflected in the anticipated draft of a policy statement by the Fall of 1989. The FDA, which has both regulatory and research components, is developing it own conflicts guidelines.

Special Issues:

1. Copyright/licensing of software: Although the FTTA provides for the licensing of educational software, no mechanism is provided for the creation of intellectual property rights in software (i.e., copyright) on the part of Government employees. Thus, although PHS scientists and administrators develop a substantial amount of commercially valuable software -- from molecular modeling to computer based expert systems in support of clinical decision making to financial/accounting management -- no intellectual property right is available that would provide a "licensee" with a right to exclude others from copying such software. This tends to make the collaborative development and licensing of software from the Government less attractive to the commercial sector.

2. Licensing of unpatented technology: The PHS laboratories develop a wide variety of materials, such as cell cultures, DNA probes, purified proteins and viral strains. Some of this material may not be sufficiently nonobvious under the patent law provision of 35 U.S.C. Section 103 to merit the issuance of a patent even though it

constitutes "patentable subject matter" under Section 101. Such "technology" has, in many cases, significant commercial value at least because of the time required to duplicate the material. Because the FTTA appears to authorize only the licensing of intellectual property rights, the NIH/ADAMHA Patent Policy Board has not permitted the licensing of "technology" generally. Thus, unpatentable research material is not licensed to industry, although most universities actively license such technology.

3. Treatment of preexisting patents as "property" under the FTTA: The FTTA permits Federal laboratories to contribute property to the cooperative research and development project under a CRADA. Several companies have suggested that NIH/ADAMHA treat preexisting patent applications, which relate to the research to be conducted under a CRADA, as property that might be contributed by the Government to a CRADA without following the patent licensing requirements of 35 U.S.C. Sections 200-212 and 37 C.F.R. Part 404. The NIH Legal Adviser has recently issued an opinion to the contrary, that the FTTA did not change the existing statutory and regulatory framework for licensing the patent applications filed on the results of intramural research.

4. Conflicts of Interest: This topic was discussed above, in the main text, but is listed here because it represents one of the major policy concerns in our implementation of the FTTA.

5. Fair Pricing: Because the DHHS has responsibilities for funding medical treatment through programs such as Medicare and Medicaid and for providing direct

medical care, as well as funding basic research, DHHS has a concern that there be a reasonable relationship between the pricing of a licensed product that is developed under a CRADA and the health and safety needs of the public. Accordingly, NIH/ADAMHA CRADAs provide that NIH/ADAMHA may require that this relationship be supported by reasonable evidence.

Summary:

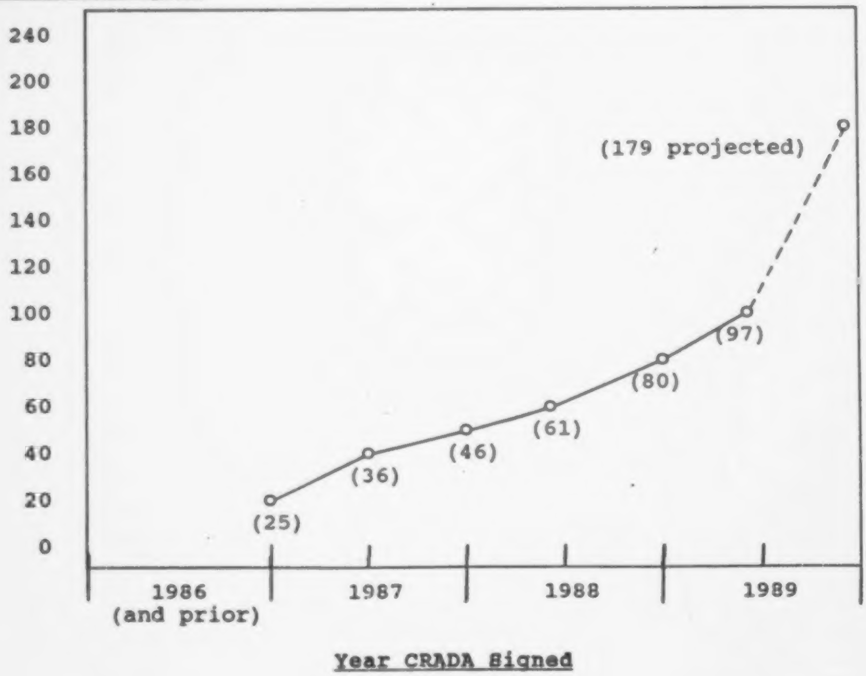
Based on our experiences to date, the FTTA provides an exciting new mechanism for the transfer of Government technology to the private sector, as well as a mechanism for enhancing the quality and quantity of our own research programs. We look forward to continuing these new associations with the private sector, both in conducting research and in developing the policies and model agreements that implement the FTTA. Thank you for this opportunity to present our testimony.

Appendix A:

PHS CRADAs (1986 to present)

	Year CRADA Initiated and number/year signed:	Cumulative Total of Signed CRADAs:
1986 (includes pre-FTTA):	25	25
1987: (Jan.-June)	11	36
(July-Dec.)	10	46
1988: (Jan.-June)	15	61
(July-Dec.)	19	80
1989 (first 5 months):	17	97
1989 (currently in negotiation):	82	179 (projected through 1989)

Cumulative Number of CRADAs Signed:



Appendix B:

NATIONAL INSTITUTES OF HEALTH (NIH)

Bureaus, Institutes, and Divisions

NIA	National Institutes on Aging
NIAID	National Institute of Allergy and Infectious Diseases
NIAMS	National Institute of Arthritis and Musculoskeletal and Skin Diseases
NCI	National Cancer Institute
	DCT Division of Cancer Treatment
	DCE Division of Cancer Etiology
	DCBD Division of Cancer Biology and Diagnosis
NHLBI	National Heart, Lung and Blood Institute
NICHD	National Institute of Child Health and Human Development
NIDCD	National Institute on Deafness and Other Communicative Disorders
NIDR	National Institute of Dental Research
NIDDK	National Institute of Diabetes and Digestive and Kidney Diseases
NIEHS	National Institute of Environmental Health Sciences
NEI	National Eye Institute
NIGMS	National Institute of General Medical Sciences
NINDS	National Institute of Neurological Disorders and Stroke
NLM	National Library of Medicine
NCNR	National Center for Nursing Research
FIC	Fogarty International Center
CC	Warren Grant Magnuson Clinical Center
DCRT	Division of Computer Research and Technology
DRG	Division of Research Grants
DRR	Division of Research Resources
DRS	Division of Research Services

ALCOHOL, DRUG ABUSE AND MENTAL HEALTH ADMINISTRATION (ADAMHA)

NIMH	National Institute of Mental Health
NIAAA	National Institute on Alcohol Abuse and Alcoholism
NIDA	National Institute on Drug Abuse

CENTERS FOR DISEASE CONTROL (CDC)

Center for Environmental Health and Injury Control
Center for Health Promotion and Education
Center for Infectious Diseases
Center for Prevention Services
National Center for Health Statistics
National Institute for Occupational Safety and Health
Agency for Toxic Substances and Disease Registry

FOOD AND DRUG ADMINISTRATION (FDA)

Center for Drugs and Biologics
Center for Food Safety and Applied Nutrition
Center for Devices and Radiological Health
Center for Veterinary Medicine
National Center for Toxicological Research

NUMBER OF CRADAs SIGNED AND IN NEGOTIATION

	Number of CRADAs in Effect	Number of CRADAs in Negotiation
National Institutes of Health		
NIA	1	1
NIAID	9	8
NIAMS	0	1
NCI-NIAID (joint)	1	-
NCI	33	24
NICHD	5	2
CC	3	1
NIDR	8	1
NIDDK	4	6
NIEHS	0	0
NEI	2	2
NHLBI	4	3
NINDS	6	3
DCRT	0	0
DRS	2	12
NIH/DHHS	3	-
Total	81	64
Alcohol, Drug Abuse and Mental Health Administration		
NIMH	6	10
NIDA	0	0
NIAAA	1	0
Total	7	10
Centers for Disease Control		
Total	9	5
Food and Drug Administration		
Total	0	3

NATIONAL INSTITUTES OF HEALTH
SIGNED CRADAS

Institute	Company/Collaborator	Date Effective
NIA	Athena NeuroSciences	11/01/87
NIAID	Transgenic Sciences	05/01/89
	Genentech	01/30/89
	Genentech	12/02/88
	Smith Kline-RIT	11/08/88
	Wyeth-Ayerst	10/07/88
	Wyeth-Ayerst	10/07/88
	Chiron Corporation	04/15/88
	MicroGeneSys, Inc.	03/28/86*
	MicroGeneSys, Inc.	03/28/86*
NCI/NIAID	Immuno	06/01/88
NCI/DCT	Sandoz	03/21/89
	Neorx Corporation	03/20/89
	Eastman Kodak Company (Sterling Drug Division)	03/11/89
	Eli Lilly	12/09/88
	Sterling Drug	12/08/88
	Hoffman-LaRoche, Inc.	08/15/88
	E.I. Dupont Company	07/01/88
	Shering Corporation	06/01/88
	Ciba-Geigy	05/01/87
	Adria Laboratories	05/01/87
	Institute for Diagnostic Research	02/05/87
	Upjohn Company	01/30/87
	Biogen Research Corporation	12/11/86
	Merck, Sharp, & Dohme Research	12/01/86
	Travenol Laboratories	10/07/86*
	Warner Lambert	03/14/86*
	Hybritech, Inc.	09/10/85*
NCI/DCE	NeoRx Corporation	03/20/89
	American Home Products (Wyeth-Ayerst Division)	02/31/89
	British Biotechnology	01/23/89
	Medical College of Illinois	09/07/88
	Upjohn Company	06/01/86*
	Collaborative Research	12/01/86
	Genentech, Inc.	02/01/85*
NCI/DCBD	American Cynamid	03/01/89
	Upjohn Company	01/23/89
	Molecular Oncology, Inc.	12/09/88

*Collaboration agreements signed before the effective date (October 20, 1986) of the Federal Technology Transfer Act (FTTA).

Institute	Company/Collaborator	Date Effective
	Hoffman-LaRoche, Inc.	05/20/88
	U.S. BioScience	04/21/88
	Dow Chemical	02/01/87
	Centocor	12/01/86
	Celltech	12/01/86
	Centocor	06/01/86*
NICHD	Electropore, Inc.	03/29/88
	Ferring Laboratories	03/10/88
	Eli Lilly Research Laboratories	11/16/87
	Institut Merieux	07/01/87
	G.D. Searle & Company	01/01/87
CC	Hemotek	08/01/88
	E.R. Squibb and Sons, Inc.	09/30/86
	Thomson-CGR, France	12/31/85*
NIDR	Eli Lilly	05/19/89
	Hoffman-LaRoche, Inc.	04/30/87
	Searle Research Division of Monsanto	02/07/87
	BSN-Groupe	1987
	Upjohn Company	12/30/86
	Warner Lambert	1986
	Genentech, Inc.	01/01/86*
	Upjohn Company	04/09/85*
NIDDK	Smith Kline and French	11/08/88
	Integrated Genetics	01/01/88
	Research Biochemicals, Inc.	10/15/87
	G.D. Searle and Company	06/12/87
NEI	Fujisawa	01/20/89
	Pfizer Central Research	02/17/83*
NHLBI	Genetic Therapy, Inc.	04/04/89
	Genetic Therapy, Inc.	04/04/89
	Xoma Corp.	11/25/88
	Genetic Therapy, Inc.	02/05/88
NINDS	Hoechst-Roussel Pharmaceuticals	04/05/89
	Applied Biosystem	05/15/88
	Biomagnetic Technologies, Inc.	10/01/87
	Cetus Corporation	08/25/87
	Sandoz Research Institute	05/25/85*
	Wallace Laboratories	05/02/85*
DRS	Beckman Instruments	12/18/87
	General Electric Systems Group	11/30/87
NIH/DHHS	Genetics Institute	12/24/87
	Institut Pasteur	03/30/87
	National Bureau of Standards	10/01/86*

ALCOHOL, DRUG ABUSE AND MENTAL HEALTH ADMINISTRATION
SIGNED CRADAS

Institute	Company/Collaborator	Date Effective
NIMH	RRI, Inc.	05/16/89
	Bristol/Intergra	08/05/88
	Upjohn Company	08/01/88
	E.R. Squibb & Sons, Inc.	10/19/87
	Hoffman-La Roche, Inc.	11/22/86*
	Genelabs, Inc.	07/01/86*
NIAAA	Bristol Myers	02/22/89

CENTERS FOR DISEASE CONTROL
SIGNED CRADAS

Center for Infectious Diseases

Company/Collaborator	Date Effective
Dupont Corporation	10/31/88
Purdue University	10/31/88
Genelabs, Inc.	9/20/88
Roche Diagnostics	9/20/88
Genelabs, Inc.	6/16/88
Thermascan, Inc.	6/10/88
Purdue University	6/10/88
Rockefeller Foundation	6/10/88
SmithKline Beckman Company	6/10/88

FOOD AND DRUG ADMINISTRATION
SIGNED CRADAS

At present no CRADAs are effective, but 3 are in various stages of negotiation.

Mr. Adler is the Director of the Office of Invention Development (OID) at the National Institutes of Health (NIH). In this capacity since January 1989, he directs the licensing and technology management programs for the NIH and its sister agency, the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA). Mr. Adler and the OID play a lead role in developing policy governing and model agreements implementing the Federal Technology Transfer Act of 1986 and the Patent Act provisions relating to licensing. He also advises the NIH/ADAMHA Patent Policy Board on matters of technology transfer policy.

Mr. Adler is a former Law Clerk to the Honorable Giles S. Rich, U. S. Court of Appeals for the Federal Circuit, and studied the areas of biotechnology law and international development as a Research Fellow at the Max Planck Institute for Foreign and International Patent, Copyright and Competition Law in Munich, Federal Republic of Germany. Mr. Adler teaches "Biotechnology Law and Policy" in the FAES graduate school at the National Institutes of Health, where he was formerly a research biochemist. He continues to be a frequent lecturer and author on the topics of technology transfer, patent law and biotechnology policy. Mr. Adler's publications include: "Biotechnology as an Intellectual Property," Science 224:357-363 (1984) and "Controlling the Applications of Biotechnology: A Critical Analysis of the Proposed Moratorium on Animal Patenting," Harvard Journal of Law & Technology 1:1-61 (1988). He recently edited a special biotechnology law issue of the American Intellectual Property Law Ass'n Quarterly Journal 16:287-563 (1989).

NIH/ADAMHA Patent Policy Board March 27, 1989

NATIONAL INSTITUTES OF HEALTH
ALCOHOL, DRUG ABUSE AND MENTAL HEALTH ADMINISTRATION

POLICY STATEMENT ON COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS AND INTELLECTUAL PROPERTY LICENSING

This Statement sets forth the policies of the National Institutes of Health (NIH) and the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA) on various aspects of cooperative research and intellectual property licensing. These policies apply to the negotiation of NIH/ADAMHA Cooperative Research and Development Agreements (CRADAs). License agreements for intellectual property rights to inventions developed under a CRADA or through the NIH/ADAMHA intramural research programs, whether negotiated by NIH/ADAMHA or the National Technical Information Service on their behalf, will also incorporate these policies. This Statement may be revised from time to time as NIH and ADAMHA consider appropriate.[*]

To implement the Federal Technology Transfer Act of 1986, (FTTA, 15 U.S.C. at § 3710), Executive Order 12591 of April 10, 1987 orders Federal laboratories to assist universities and the private sector in broadening our national technology base by moving new knowledge from the research laboratory into the development of new products and processes. While Federal patent law (35 U.S.C. at §§ 200-212) authorizes the licensing of Government-owned patent rights, the FTTA seeks to facilitate technological collaboration at an earlier stage. Thus, the FTTA authorizes Federal laboratories to enter into CRADAs, and to agree to grant intellectual property rights in advance to collaborators for inventions made in whole or part by Federal employees under the CRADA. Besides assisting in the transfer of commercially useful technologies from Federal laboratories to the marketplace, CRADAs make outside resources more accessible to Federal laboratories.

NIH and ADAMHA, agencies of the Public Health Service (PHS) within the Department of Health and Human Services (DHHS), are among the world's preeminent biomedical research organizations. Their general mission is to conduct biomedical and behavioral research that will lead to the better health of the American people. For the NIH/ADAMHA investigator, this agency mission prescribes the exploration of ideas, the communication of ideas and information to colleagues, and a responsibility for the prompt and accurate publication of findings. Under the FTTA, 15 U.S.C. at § 3710a(a)(2), technology transfer, consistent with mission responsibilities, is also a responsibility of each laboratory science and engineering professional. To support their mission, NIH/ADAMHA have developed an interdisciplinary and synergistic research environment that promotes the free exchange of ideas and information. In order to safeguard the collegiality and integrity of, as well as public confidence in, the NIH/ADAMHA research programs, the following cooperative research and technology transfer policies have been adopted.

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[*] Questions or comments about this Statement and requests for updated versions should be directed to the NIH Office of Invention Development at (301) 496-0750. This Statement is effective on an interim basis, and will be revised after October 1, 1989.

1. Research Freedom:

NIH/ADAMHA investigators generally are free to choose the subject matter of their research, consistent with the mission of their Institute and the research programs of their Laboratories. No CRADA or license agreement may contravene this freedom.

2. Research Policy:

NIH/ADAMHA research results generally are disseminated freely through publication in the scientific literature and presentations at public fora. Brief delays in this dissemination of research results may be permitted under a CRADA as necessary in order to file corresponding patent or other intellectual property applications. NIH/ADAMHA consider the filing of such applications to be an important component of their research efforts.

3. Cooperative Research and Development under a CRADA:

As defined by the FTTA, 15 U.S.C. § at 3710a(d)(1), a CRADA means any agreement between one or more Federal laboratories and one or more non-Federal parties, under which the Government provides personnel, services, facilities, equipment or other resources (but not funds), and the non-Federal parties provide funds, personnel, services, facilities, equipment or other resources toward the conduct of specified research or development efforts. Cooperative research and development activities are intended to facilitate the transfer of federally funded research and development for use by State and local governments, universities and the private sector, particularly small business.

4. NIH/ADAMHA CRADAs:

As adopted by NIH/ADAMHA, a CRADA is a standardized agreement intended to provide an appropriate legal framework for, and to expedite the approval of, cooperative research and development projects. The use of CRADAs is encouraged for cooperative efforts because they permit NIH/ADAMHA to accept, retain, and use funds, personnel, services, and property from collaborating parties and to provide personnel, services, and property to collaborating parties. NIH/ADAMHA may permit their investigators to enter into CRADAs with collaborators who will make a significant intellectual contribution to the research project undertaken or who will contribute essential research materials or technical resources not otherwise reasonably available. While NIH/ADAMHA welcome contributions to their gift funds for research purposes, they do not view CRADAs as a general funding source or a mechanism for sponsored research. This approach to implementing the FTTA has been chosen in order to maintain the public's confidence in NIH/ADAMHA through maintaining an independence from reliance on industry funding.

5. Selection of Collaborators under a CRADA:

Collaborations under a CRADA may be suggested by potential collaborators or by NIH/ADAMHA investigators. Generally, the decision to initiate the approval process for a CRADA is made by the involved NIH/ADAMHA investigator and laboratory chief based on scientific considerations and the desire for the public to benefit from the commercialization of particular NIH/ADAMHA research. For some cooperative projects, where the development and commercialization potential is more immediate relative to the basic research aspects, NIH/ADAMHA may seek a collaborator(s) which has both scientific expertise and commercialization capabilities. In certain areas of research, *e.g.*, where the Government has the intellectual lead or where both scientific and commercialization capabilities are deemed essential at the outset, NIH/ADAMHA may competitively seek a collaborator through Federal Register notification. The PHS has also developed policy guidelines for ensuring fairness of access to PHS laboratories such as NIH and ADAMHA in the process of initiating and developing CRADAs.

6. Proprietary or Confidential Information and Materials:

NIH/ADAMHA recognize that an effective collaborative research program may require the disclosure of proprietary information to NIH/ADAMHA investigators. Although agreements to maintain confidentiality are permitted under a CRADA, collaborators should limit their disclosure of proprietary information to the amount necessary to carry out the research plan of the CRADA. The mutual exchange of confidential information, *e.g.*, patient data, should be similarly limited. NIH/ADAMHA also recognize that cooperative research may require the exchange of proprietary research materials. Such materials may be used only for the purposes specified in the research plan set forth in the CRADA. All parties to the CRADA will agree to keep CRADA research results confidential to the extent permitted by law until they are published in the scientific literature or presented at a public forum.

7. **Treatment of Data and Research Products Produced under a CRADA:**

The NIH/ADAMHA investigator and the collaborator will agree to exchange all data and research products developed in the course of research under a CRADA whether developed solely by NIH/ADAMHA, jointly with the collaborator, or solely by the collaborator. In general, tangible research products developed under a CRADA will be shared equally by the parties to the CRADA. All parties to a CRADA will be free to utilize such data and research products for their own purposes. Data and research products developed solely by the collaborator may be designated as proprietary by the collaborator when they are wholly separable from the data and research products developed jointly with NIH/ADAMHA investigators. However, except as may be afforded through intellectual property rights that require public disclosure of the protected subject matter (*e.g.*, patents), NIH/ADAMHA will not agree to exclude others from utilizing or commercializing the data or research products developed solely by NIH/ADAMHA investigators or jointly with the collaborator under a CRADA.

8. **Ownership and Licensing of NIH/ADAMHA Intellectual Property Rights:**

Pursuant to the FTTA, 15 U.S.C. at § 3710a(b)(2), a Federal laboratory is authorized to own and license patent rights to inventions made in whole or part by its employees under a CRADA. The term "invention" is defined at § 3703(9) to mean any invention or discovery which is or may be patentable or otherwise protected under Title 35 or any novel variety of plant which is or may be protectable under the Plant Variety Protection Act, 7 U.S.C. § 2321 *et seq*. The patent law, 35 U.S.C. at § 207, authorizes the ownership and licensing of intramural inventions. Executive Order 12591 at § 1(b)(1)(B) further authorizes the transfer of Government intellectual property rights. Although the FTTA speaks broadly of the transfer of "technology," NIH/ADAMHA do not have statutory authority to license (or to agree to limit dissemination of) technology developed in whole or part by their investigators under a CRADA unless a patent, PVPA certificate or other intellectual property application has been filed for that technology. NIH/ADAMHA will retain the Government ownership interest in, but license rights to, all intellectual property rights to inventions developed solely through intramural research or developed in whole or in part by their investigators under a CRADA.

9. **General Licensing Policy:**

NIH/ADAMHA recognize that under the FTTA and the patent licensing law to which it refers, Congress and the President have chosen to utilize the patent system as the primary mechanism for transferring Government inventions to the private sector. The importance of patents to commercialization in the biomedical field is further reflected by the Drug Price Competition and Patent Term Restoration Act of 1984 (Pub. L. 98-417). A fundamental principle of the patent system is that the owner of a patent have a time-limited "right to exclude others from making, using, or selling the [patented] invention." The reason for such a period of exclusivity is to encourage industry to invest the resources necessary to bring an invention from the discovery stage through subsequent development, clinical trials, regulatory approvals, and ultimately into commercial production. NIH/ADAMHA accordingly are willing to grant exclusive commercialization licenses under their patent or other intellectual property rights in cases where substantial additional risks, time and costs must be undertaken by a licensee prior to commercialization. Under a CRADA, NIH/ADAMHA are also willing to agree to grant exclusive commercialization licenses in advance to collaborators. NIH/ADAMHA will attempt, however, to license their intramural inventions nonexclusively in cases where an invention reflects a relatively more advanced stage in its commercial development, *e.g.*, when an NIH/ADAMHA investigator invents a patentable new therapeutic use for a known and FDA approved compound.

Federal laboratories are authorized to negotiate license agreements for Government-owned patent rights in intramural inventions pursuant to 35 U.S.C. § 207. Although § 207 does not apply to intellectual property license agreements authorized by the FTTA for inventions made under a CRADA, NIH/ADAMHA have adopted the following approach of § 207 for all license agreements:

> Each Federal Agency [may] ... grant nonexclusive, exclusive, or partially exclusive licenses under federally owned patent applications, patents, or other forms of protection ... on such terms and conditions ... as determined appropriate in the public interest.

NIH/ADAMHA have determined it to be appropriate in the public interest to grant nonexclusive research licenses and either exclusive or nonexclusive commercialization licenses to DHHS owned intellectual property rights according to the plan discussed below.

10. Government Intellectual Property Rights:

For inventions developed wholly by NIH/ADAMHA investigators or jointly with a collaborator under a CRADA, NIH/ADAMHA are required by the FTTA at 15 U.S.C. § 3710a(b)(2) to retain at least a nonexclusive, irrevocable, paid-up license to practice the invention or to have the invention practiced throughout the world by or on behalf of the U. S. Government. When granting exclusive or partially exclusive licenses to NIH/ADAMHA intramural inventions, 35 U.S.C. § 208, as implemented by 37 C.F.R. § 404.7(2)(i), requires the reservation of similar Government rights. NIH/ADAMHA will not assert an ownership right in inventions made solely by a collaborator under a CRADA, but will require the grant of a research license, as described below, to the Government for inventions made wholly by a collaborator under a CRADA.

11. Research Licenses:

NIH/ADAMHA will reserve the right under any CRADA and intellectual property license to grant nonexclusive licenses to make and to use the invention for purposes of research involving the invention itself, and not for purposes of commercial manufacture or in lieu of purchase as a commercial product for use in other research. The purpose of the research license is to facilitate basic academic research. NIH/ADAMHA intend to consult with any involved commercialization licensee(s) before granting research licenses to commercial entities.

12. Commercialization Licenses:

NIH/ADAMHA are willing to consider requests for nonexclusive or exclusive commercialization licenses to intellectual property rights to inventions developed under a CRADA or in the course of intramural research, pursuant to applicable statutes and regulations. Under a CRADA, NIH/ADAMHA generally will grant a time-limited option to negotiate, in good faith, the terms of a license that fairly reflects the relative contributions of the parties, the risks incurred by the collaborator and the costs of subsequent research and development needed to bring the results of CRADA research to the marketplace. NIH/ADAMHA contemplate the drafting of a model invention license to serve as the starting point for license negotiations. It is contemplated further that such a model will reduce negotiations essentially to matters of execution fees, royalty rates and minimum annual royalties. Royalty rates will be based on product sales and the rates conventionally granted in the field identified in the CRADA's research plan for inventions with reasonably similar commercial potential. Royalty rates generally will not exceed a rate within the range of 5 - 8 % for exclusive commercialization licenses. Contingent royalty schemes based on, *e.g.*, patent issuance or nonissuance, and clauses treating the stacking of royalties or packaging of other inventions developed under the CRADA may be provided. Exclusive licensees will be expected to reimburse NIH/ADAMHA for intellectual property related expenses, and may be permitted to offset such reimbursement against future product royalties.

13. Nonexclusive Commercialization Licenses:

Unless a request for exclusive commercialization license is made under a CRADA or submitted for an intramural invention, NIH/ADAMHA will attempt to license their inventions nonexclusively. Such nonexclusive licenses generally will follow the guidelines of 37 C.F.R. Part 404.

14. Exclusive Commercialization Licenses:

All NIH/ADAMHA exclusive commercialization licenses will require the submission by a prospective licensee of an acceptable development and commercialization plan as described by 35 U.S.C. § 209(a) and subsequent, periodic reports on utilization of the invention as described by § 209(f)(1). All such plans and reports will be treated in confidence and as privileged from disclosure under the Freedom of Information Act. Modification provisions as described by § 209(f)(2)-(4) may apply. In appropriate cases, NIH/ADAMHA may also reserve the right to grant separate exclusive commercialization licenses in various fields of use. The remaining provisions of 35 U.S.C. §§ 200-212 will also apply to licenses to NIH/ADAMHA intramural inventions.

NIH/ADAMHA also consider the following provisions for exclusive commercialization licenses to be necessary and appropriate in the public interest:

(i) the exclusive licensee must pledge its reasonable best efforts to commercialize a licensed invention and the development and commercialization plan mentioned above may serve as the measure of such efforts;

(ii) NIH/ADAMHA shall have the right, after notice and opportunity to cure, to terminate or render nonexclusive any license granted: (1) if the licensee is not reasonably engaged in research, development, clinical trials, manufacturing, marketing, sublicensing, or other activities reasonably necessary to the expeditious commercial dissemination of the licensed invention; or (2) when the licensee cannot reasonably satisfy unmet health and safety needs;

(iii) in order to maximize the commercialization of the licensed invention in other fields of use not utilized by the exclusive licensee through ongoing development, manufacturing or sublicensing, NIH/ADAMHA reserve the right to require the licensee to grant sublicenses to responsible applicants, on reasonable terms, in such other fields of use, unless the licensee can reasonably demonstrate that such a sublicense would be contrary to sound and reasonable business practice and the granting of the sublicense would not materially increase the availability to the public of the licensed invention; and

(iv) exclusive licensees to DHHS inventions, whether developed under a CRADA or through intramural research, must agree to not unreasonably deny requests for sublicense or cross license rights from future CRADA collaborators when the possibility of acquiring such derivative rights is necessary in order to permit a proposed cooperative research project with NIH/ADAMHA to go forward, and the exclusive licensee has been given a reasonable opportunity to join as a party to the proposed CRADA

15. Compliance under a CRADA with Other Policies:

For research conducted pursuant to a CRADA, collaborators must agree to comply with PHS, NIH and ADAMHA policies and guidelines concerning, *e.g.*, human subjects research, the use of research animals including nonwild chimpanzees, recombinant DNA and other policy statements as may be promulgated from time to time.

16. Pricing:

DHHS has responsibility for funding basic biomedical research, for funding medical treatment through programs such as Medicare and Medicaid, for providing direct medical care and, more generally, for protecting the health and safety of the public. Because of these responsibilities, and the public investment in the research that contributes to a product licensed under a CRADA, DHHS has a concern that there be a reasonable relationship between the pricing of a licensed product, the public investment in that product, and the health and safety needs of the public. Accordingly, exclusive commercialization licenses granted for NIH/ADAMHA intellectual property rights may require that this relationship be supported by reasonable evidence.

17. Waivers:

NIH/ADAMHA will consider requests to modify any of the foregoing policies in special cases where public health exigencies or commercial situations warrant such a modification. Modifications dealing with business terms such as royalties are not decided by the NIH/ADAMHA investigators and should be discussed with the appropriate NIH/ADAMHA technology management personnel.

18. Special Consideration and Preference under a CRADA:

NIH/ADAMHA will give special consideration to entering into CRADAs with small business firms and consortia involving small business firms; and will give preference to business units located in the United States which agree to manufacture substantially in the United States products which embody inventions developed in the course of research under CRADAs.

NIH/ADAMHA Patent Policy Board April 24, 1989

NATIONAL INSTITUTES OF HEALTH
ALCOHOL, DRUG ABUSE AND MENTAL HEALTH ADMINISTRATION

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT[*]

This Cooperative Research and Development Agreement, hereinafter referred to as the "CRADA," consists of this Cover Page, an attached Agreement, a Signature Page and various Appendices referenced in the Agreement. This Cover Page serves to identify the Parties to this CRADA:

(1) the following Bureau(s), Institute(s) or Division(s) of the National Institutes of Health and/or the Alcohol, Drug Abuse and Mental Health Administration: ______________
____, hereinafter singly or collectively referred to as the "NIH/ADAMHA;" and

(2) ____, which has offices at ____
____, hereinafter referred to as the "Collaborator."

Although drafted for two Parties, the attached CRADA may also be used for any number. This Cover Page, however, should be modified by repeating block (2) to identify other Parties to the CRADA. All non-NIH/ADAMHA Parties are hereinafter collectively referred to as the "Collaborator." Use of the terms "Collaborator," "Party" and "Parties" should be construed as appropriate for the actual number of CRADA participants.

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[*] This Cooperative Research and Development Agreement form is effective on an interim basis, and will be revised after October 1, 1989 for use in CRADAs entered into by NIH/ADAMHA after that date. Questions or comments about this CRADA and requests for updated versions should be directed to the NIH Office of Invention Development at (301) 496-0750.

NIH/ADAMHA Patent Policy Board April 24, 1989

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT

Article 1. INTRODUCTION

This Cooperative Research and Development Agreement (CRADA) between NIH/ADAMHA and the Collaborator will be effective when signed by all parties. By signing this CRADA, the Collaborator acknowledges that it has received and read a copy of the Policy Statement on Cooperative Research and Development Agreements and Intellectual Property Licensing which is attached as Appendix A. The research and development project(s) which will be undertaken by each of the Parties in the course of this CRADA are detailed in the Research Plan (RP) which is attached as Appendix B. The funding and staffing commitments of the Parties are set forth in Appendix C. Any exceptions or changes to the CRADA are set forth in Appendix D.

Article 2. DEFINITIONS

As used in this CRADA, the following terms shall have the indicated meanings:

2.1 **"Cooperative Research and Development Agreement"** or **"CRADA"** means this Agreement, entered into by NIH/ADAMHA pursuant to the Federal Technology Transfer Act of 1986 and Executive Order 12591 of October 10, 1987.

2.2 **"Proprietary Information"** means confidential scientific, business or financial information provided that such information:

- 2.2.1 is not publicly known or available from other sources who are not under a confidentiality obligation to the source of the information;
- 2.2.2 has not been made available by its owners to others without a confidentiality obligation;
- 2.2.3 is not already known by or available to the receiving Party without a confidentiality obligation; or
- 2.2.4 does not relate to potential hazards or cautionary warnings associated with the production, handling or use of the subject matter of the Research Plan of this CRADA.

2.3 **"Subject Data"** means all recorded information first produced in the performance of this CRADA.

2.4 **"Research Results"** means all tangible materials other than Subject Data first produced in the performance of this CRADA.

2.5 **"Subject Invention"** means any invention, conceived or reduced to practice in the performance or research under this CRADA, that may be patentable under 35 U.S.C. § 101 or § 161, protectable under 7 U.S.C. § 2321, or otherwise protectable by other types of U. S. or foreign **"Intellectual Property"** ("IP") right.

2.6 **"Government"** means the U.S. Government and any of its agencies.

2.7 **"Research Plan"** or **"RP"** means the statement in Appendix B of the respective research and development commitments of the Parties to this CRADA.

2.8 **"Principal Investigator"** or **"PI"** means the persons designated respectively by the Parties to this CRADA who will be responsible for the scientific and technical conduct of the RP.

Article 3. COOPERATIVE RESEARCH

3.1 Research Team. The Parties agree to establish a joint research and development team (hereinafter referred to as the "Team") comprising at least the Principal Investigators designated pursuant to Article 3.3 to conduct and monitor the research in accordance with the RP. Although the members of the Team shall be considered as having been delegated to the Team, they shall continue to remain employed by their respective employers under their respective terms of employment.

3.2 Review of Work. Periodic conferences shall be held by the Team to review work progress. It is understood that the nature of this cooperative research precludes a guarantee of its completion within the specified period of performance or limits of allocated financial or staffing support. Accordingly, research under this CRADA is to be performed on a best efforts basis.

3.3 Principal Investigators. NIH/ADAMHA research work under this CRADA will be performed by the Laboratory identified in the RP, and the NIH/ADAMHA Principal Investigator (PI) designated in the RP will be responsible for the scientific and technical conduct of this project on behalf of NIH/ADAMHA. Also designated in the RP is the Collaborator PI who will be responsible for the scientific and technical conduct of this project on behalf of the Collaborator.

3.4 Research Plan Change. The RP may be modified by mutual written consent of the Principal Investigators. Substantial changes in the scope of the RP will be treated as amendments under Article 14.6.

Article 4. REPORTS

4.1 Interim Reports. The Parties shall exchange formal written interim progress reports on a schedule agreed to by the PIs, but at least within six (6) months after this CRADA becomes effective and at least within every six (6) months thereafter. Such reports shall set forth the technical progress made, identifying such problems as may have been encountered and establishing goals and objectives requiring further effort.

4.2 Final Reports. The Parties shall exchange final reports of their results within four (4) months after completing the projects described in the RP or after the termination of this CRADA.

Article 5. FINANCIAL AND STAFFING OBLIGATIONS

5.1 NIH/ADAMHA and Collaborator Contributions. The NIH/ADAMHA contribution to the RP in the form of personnel, services and property only is designated in Appendix C. The Collaborator contribution to the RP in the form of personnel, services, property, support for staffing and/or funding is designated in Appendix C. Payment schedules, if applicable, are also indicated in Appendix C.

5.2 Insufficient and Excess Funds. NIH/ADAMHA shall not be obligated to perform any of the research specified herein or to take any other action required by this CRADA if the funding is not provided as set forth in Appendix C. NIH/ADAMHA shall return excess funds to the Collaborator when it sends it final fiscal report pursuant to Article 5.3, except for staffing support pursuant to Article 11.3.

5.3 Accounting Records. NIH/ADAMHA shall maintain separate and distinct current accounts, records, and other evidence supporting all its obligations under this CRADA, and shall provide the Collaborator an annual report reflecting the use of the Collaborator's funds and a final such fiscal report at the time that final reports are exchanged pursuant to Article 4.2.

Article 6. TITLE TO PROPERTY

6.1 Capital Equipment. The purchase or use of capital equipment to carry out this CRADA does not affect the ownership rights that would otherwise apply. Equipment purchased by NIH/ADAMHA with funds provided by the Collaborator shall be the property of NIH/ADAMHA. All capital equipment provided under this CRADA by one party for the use of another Party remains the property of the providing Party unless other disposition is mutually agreed upon by in writing by the PIs. If title to this equipment remains with the providing Party, that Party is responsible for maintenance of the equipment and the costs of its transportation to and from the site where it will be used.

Article 7. INTELLECTUAL PROPERTY RIGHTS AND APPLICATIONS

7.1 Reporting. The Parties shall promptly report to each other in writing each Subject Invention resulting from the research conducted under this CRADA that is reported to them by their respective employees. Such reports shall be treated in confidence by the receiving Party until such time as a patent or other Intellectual Property (IP) application, as appropriate, claiming that Subject Invention has been filed. Because of the royalty sharing provisions for Government inventors in the Federal Technology Transfer Act of 1986, and in view of Article 8.4 of this CRADA which grants the Government only a research license on inventions made solely by the Collaborator, the Collaborator acknowledges a special duty to report all Subject Inventions to NIH/ADAMHA so that NIH/ADAMHA may determine whether or not inventorship properly includes NIH/ADAMHA investigators.

7.2 Collaborator Employee Inventions. The Collaborator may elect to retain IP rights to any Subject Invention made solely by a Collaborator employee. The Collaborator shall notify NIH/ADAMHA promptly upon making this election. If the Collaborator does not elect to retain its IP rights, the Collaborator shall offer to assign these IP rights to the Subject Invention to NIH/ADAMHA pursuant to Article 7.5. If NIH/ADAMHA declines such assignment, the Collaborator may release its IP rights to employee inventors pursuant to Article 7.6.

7.3 NIH/ADAMHA Employee Inventions. NIH/ADAMHA on behalf of the U.S. Government may elect to retain IP rights to each Subject Invention made solely by NIH/ADAMHA employees. If NIH/ADAMHA does not elect to retain IP rights, NIH/ADAMHA shall offer to assign these IP rights to such Subject Invention to the Collaborator pursuant to Article 7.5. If the Collaborator declines such assignment, NIH/ADAMHA may release IP rights in such Subject Invention to its employee inventors pursuant to Article 7.6.

7.4 Joint Inventions. Each Subject Invention made jointly by NIH/ADAMHA and Collaborator employees shall be jointly owned by NIH/ADAMHA and the Collaborator. The Collaborator may elect to file the joint patent or other IP application(s) thereon and shall notify NIH/ADAMHA promptly upon making this election. If the Collaborator decides to file such applications, it shall do so in a timely manner and at its own expense. If the Collaborator does not elect to file such application(s), NIH/ADAMHA on behalf of the U. S. Government shall have the right to file the joint applications in a timely manner and at its own expense. If either Party decides not to retain its IP rights to a jointly owned Subject Invention, it shall offer to assign such rights to the other Party pursuant to Article 7.5. If the other Party declines such assignment, the offering Party may release its IP rights to employee inventors pursuant to Article 7.6.

7.5 Filing of Patent Applications. With respect to Subject Inventions made by the Collaborator as described in Article 7.2 or by NIH/ADAMHA as described in Article 7.3, a Party exercising its right to elect to retain IP rights to a Subject Invention agrees to file patent or other IP applications in a timely manner and at its own expense. The Party may elect not to file a patent or other IP application thereon in any particular country or countries provided it so advises the other Party ninety (90) days prior to the expiration of any applicable filing deadline, priority period or statutory bar date, and hereby agrees to assign its IP right, title and interest in such country or countries to the Subject Invention to the other Party and to cooperate in the preparation and filing of a patent or other IP application. In any countries in which title to patent or other IP rights is transferred to the Collaborator, the Collaborator agrees that NIH/ADAMHA inventors will share in any royalty distribution that the Collaborator pays to its own inventors.

7.6 Release to Inventors. In the event neither of the Parties to this CRADA elects to file a patent or other IP application on a Subject Invention, either or both (if a joint invention) may release their IP rights to their respective employee inventor(s) with a non-exclusive, non-transferrable, royalty-free license being retained by each Party.

7.7 Patent Expenses. The expenses attendant to the filing of patent or other IP applications generally shall be paid by the Party filing such application. If an exclusive license to any Subject Invention is granted to the Collaborator, the Collaborator shall reimburse NIH/ADAMHA for the reasonable past and Collaborator-approved ongoing funds expended worldwide for filing, prosecuting and maintaining any applications claiming such exclusively-licensed inventions and any patents or other IP grants that may issue on such applications. The Collaborator may waive its exclusive license rights on any application, patent or other IP grant at any time, and incur no subsequent compensation obligation for that application, patent or IP grant.

7.8 Prosecution of Intellectual Property Applications. Each Party shall provide the other Party with copies of the applications it files on any Subject Invention along with the power to inspect and make copies of all documents retained in the patent or other IP application files by the applicable patent or other IP office. The Parties agree to consult with each other with respect to the prosecution of NIH/ADAMHA Subject Inventions described in Article 7.3 and joint Subject Inventions described in Article 7.4. If the Collaborator elects to file and prosecute IP applications on joint Subject Inventions pursuant to Article 7.4, NIH/ADAMHA will be granted an associate power of attorney (or its equivalent) on such IP applications.

Article 8. LICENSING

8.1 Option for Exclusive Commercialization License. With respect to Government IP rights to any Subject Invention not made solely by the Collaborator's employees for which a patent or other IP application is filed, NIH/ADAMHA hereby grants to the Collaborator an option to negotiate, in good faith, the terms of an exclusive or nonexclusive commercialization license that fairly reflect the relative contributions of the Parties to the invention and the CRADA, the risks incurred by the Collaborator and the costs of subsequent research and development needed to bring the invention to the marketplace. The license will specify the licensed fields of use, breadth of exclusivity and royalties. Royalty rates will be based on product sales and the rates conventionally granted in the field identified in the RP for inventions with reasonably similar commercial potential. Royalty rates generally will not exceed a rate within the range of 5 - 8 % for exclusive commercialization licenses. Contingent royalty schemes based on, e.g., patent issuance or nonissuance, and provisions treating the stacking of royalties or packaging of other licensed inventions developed under this CRADA may be provided. Exclusive licensees will be expected to reimburse NIH/ADAMHA for IP expenses related to each licensed intellectual property, and may be permitted to offset such reimbursement against future product royalties.

8.2 Exercise of License Option. The option of Article 8.1 must be exercised by written notice mailed within three (3) months after the patent or other IP application is filed to the NIH Office of Invention Development, Building 31, Room B1C38, National Institutes of Health, Bethesda, MD 20892. Exercise of this option by the Collaborator initiates a negotiation period that expires nine (9) months after the patent or other IP application filing date. If the last proposal by the Collaborator has not been responded to in writing by NIH/ADAMHA within this nine (9) month period, the negotiation period shall be extended to expire one (1) month after NIH/ADAMHA so responds, during which month the Collaborator may accept in writing the final license proposal of NIH/ADAMHA. After that time, NIH/ADAMHA will be free to license such IP rights to others.

8.3 Pricing. NIH/ADAMHA have a concern that there be a reasonable relationship between the pricing of a licensed product, the public investment in that product, and the health and safety needs of the public. Accordingly, exclusive commercialization licenses granted for NIH/ADAMHA intellectual property rights may require that this relationship be supported by reasonable evidence.

8.4 Government Intellectual Property Rights. For inventions developed wholly by NIH/ADAMHA investigators or jointly with a Collaborator under this CRADA, NIH/ADAMHA are required by the Federal Technology Transfer Act of 1986, 15 U.S.C. at § 3710a(b)(2), to retain at least a nonexclusive, irrevocable, paid-up license to practice the invention or to have the invention practiced throughout the world by or on behalf of the U. S. Government. For inventions developed wholly by the Collaborator under this CRADA, the Collaborator agrees to grant a research license as described in Article 8.5 to the Government.

8.5 Research Licenses. NIH/ADAMHA reserve the right under any IP license granted to the Collaborator under this CRADA to grant nonexclusive licenses to third parties to make and to use the licensed invention for purposes of research involving the invention itself, and not for purposes of commercial manufacture or in lieu of purchase as a commercial product for use in other research. NIH/ADAMHA intend to consult with their exclusive commercialization licensee(s) before granting research licenses to commercial entities.

8.6 Joint Inventions not Exclusively Licensed. In the event that the Collaborator does not acquire an exclusive commercialization license to IP rights in joint Subject Inventions described in Article 7.4, then each Party shall have the right to use the joint Subject Invention and to license its use to others. *The Parties may agree* to a joint licensing approach for such IP rights.

Article 9. PROPRIETARY RIGHTS AND PUBLICATION

9.1 Right of Access. NIH/ADAMHA and the Collaborator agree to exchange all Subject Data and Research Results produced in the course of research under this CRADA, whether developed solely by NIH/ADAMHA, jointly with the Collaborator, or solely by the Collaborator. Tangible research products developed under a CRADA will be shared equally by the Parties to the CRADA unless other disposition is agreed to by the Principal Investigators. All Parties to this CRADA will be free to utilize Subject data and Research Results for their own purposes, consistent with their obligations under this CRADA.

9.2 Ownership of Subject Data and Research Results. Subject to the sharing requirements of Article 9.1, the producing Party will retain ownership of and title to all Subject Inventions, all Subject Data and all Research Results produced solely by their investigators. Jointly developed Subject Inventions, Subject Data and Research Results will be jointly owned. However, except as may be afforded through IP rights that require public disclosure of the protected subject matter (e.g., patents), NIH/ADAMHA do not have statutory authority to license (or agree with the Collaborator to limit dissemination) of Subject Data or Research Results developed solely by NIH/ADAMHA investigators or jointly with the Collaborator. Accordingly, NIH/ADAMHA will not agree to exclude others from utilizing or commercializing such Subject Data or Research Results.

9.3 Proprietary and Confidential Information. Each Party agrees to limit its disclosure of Proprietary Information to the amount necessary to carry out the Research Plan of this CRADA, and shall place a confidentiality notice on all such information. Research materials required for the RP may also be designated as Proprietary Information. Each Party receiving Proprietary Information agrees that any information so designated shall be used by it only for the purposes described in the attached Research Plan. Any Party may object to the designation of information as Proprietary Information by another Party and may decline to accept such information. Data and research products developed solely by the Collaborator may be designated as Proprietary Information when they are wholly separable from the data and research products developed jointly with NIH/ADAMHA investigators, and advance designation of such data and product categories is set forth in the RP. The exchange of confidential information, e.g., patient data, should be similarly limited and treated. Unless disclosure is otherwise mutually agreed upon, all Parties to this CRADA agree to keep CRADA Subject Data and Research Results confidential, to the extent permitted by law, until they are published or corresponding patent or other IP application(s) have been filed.

9.4 **Protection of Proprietary Information**. Proprietary Information shall not be disclosed, copied, reproduced or otherwise made available to any other person or entity without the consent of the owning Party except as required under court order or the Freedom of Information Act (5 U.S.C. § 552). Each Party agrees to use its best efforts to maintain the confidentiality of Proprietary Information. Each Party agrees that another Party is not liable for the disclosure of Proprietary Information which, after notice to and consultation with the concerned Party, another Party in possession of the Proprietary Information determines may not lawfully be withheld, provided the concerned Party has been given an opportunity to obtain a court order to enjoin disclosure.

9.5 **Duration of Confidentiality Obligation**. The obligation to maintain the confidentiality of Proprietary Information shall expire at the earlier of the date when the information is no longer Proprietary Information as defined in Article 2.2 or three (3) years after the expiration or termination date of this CRADA. The Collaborator may request an extension to this term when necessary to protect Proprietary Information relating to products not yet commercialized.

9.6 **Publication**. The Parties are encouraged to make publicly available the results of their research. Before either Party submits a paper or abstract for publication or otherwise intends to publicly disclose information about a Subject Invention, Subject Data or Research Results, the other Party shall be provided thirty (30) days to review the proposed publication or disclosure to assure that Proprietary Information is protected. The publication or other disclosure shall be delayed for up to (thirty) 30 additional days upon written request by any Party as necessary to preserve U. S. or foreign patent or other IP rights.

Article 10. REPRESENTATIONS AND WARRANTIES

10.1 **Representations and Warranties of NIH/ADAMHA**. NIH/ADAMHA hereby represents and warrants to the Collaborator that the Official signing this CRADA has authority to do so.

10.2 **Representations and Warranties of the Collaborator**. The Collaborator hereby represents and warrants to NIH/ADAMHA that the Collaborator has the requisite power and authority to enter into this CRADA and to perform according to its terms, and that the Collaborator's Official signing this CRADA has authority to do so. The Collaborator further represents that it is financially able to satisfy any funding commitments made in Appendix C.

Article 11. TERMINATION

11.1 **Termination By Mutual Consent**. NIH/ADAMHA and the Collaborator may terminate this CRADA, or portions thereof, at any time by mutual written consent. In such event the Parties shall specify the disposition of all property, inventions, patent or other IP applications and other results of work accomplished or in progress, arising from or performed under this CRADA.

11.2 **Unilateral Termination**. Either NIH/ADAMHA or the Collaborator may unilaterally terminate this entire CRADA at any time by giving written notice at least thirty (30) days prior to the desired termination date, and any rights accrued in property, patents or other IP shall be disposed of as in 11.1.

11.3 **Staffing**. If this CRADA is mutually or unilaterally terminated prior to its expiration, funds will nevertheless remain available to NIH/ADAMHA for continuing any staffing commitment made by the Collaborator pursuant to Article 5.1 above and Appendix C, if applicable, for a period of six (6) months after such termination. If there are insufficient funds to cover this expense, the Collaborator agrees to pay the difference.

11.4 **New Commitments**. No Party shall make new commitments related to this CRADA after a mutual or unilateral termination and shall, to the extent feasible, cancel all outstanding commitments and contracts by the termination date.

11.5 Termination Costs. Concurrently with the exchange of final reports pursuant to Articles 4.2 and 5.3, NIH/ADAMHA shall submit to the Collaborator for payment a statement of all costs incurred prior to the date of termination and for all reasonable termination costs including the cost of returning Collaborator property or removal of abandoned property.

Article 12. DISPUTES

12.1 Settlement. Any dispute arising under this CRADA which is not disposed of by agreement of the Principal Investigators shall be submitted jointly to the signatories of this CRADA. If the signatories are unable to jointly resolve the dispute within thirty (30) days after notification thereof, the Assistant Secretary of Health (or his/her designee) shall propose a resolution. Nothing in this section shall prevent any Party from pursuing any and all administrative and/or judicial remedies which may be available.

12.2 Continuation of Work. Pending the resolution of any dispute or claim pursuant to this Article, the Parties agree that performance of all obligations shall be pursued diligently in accordance with the direction of the NIH/ADAMHA signatory.

Article 13. LIABILITY

13.1 Property. The U.S. Government shall not be responsible for damages to any property of the Collaborator provided to it or acquired by it pursuant to this CRADA.

13.2 No Warranties. Except as specifically stated in Article 10, the Parties make no express or implied warranty as to any matter whatsoever, including the conditions of the research or any invention or product, whether tangible or intangible, made, or developed under this CRADA, or the ownership, merchantability, or fitness for a particular purpose of the research or any invention or product.

13.3 Indemnification. The Collaborator agrees to hold the U. S. Government harmless and to indemnify the Government for all liabilities, demands, damages, expenses and losses arising out of the use by the Collaborator for any purpose of the Subject Data, Research Results and/or Subject Inventions produced in whole or part by NIH/ADAMHA employees under this CRADA, unless due to the negligence of NIH/ADAMHA, its employees or agents. The Collaborator shall be liable for any claims or damages it incurs in connection with this CRADA. NIH/ADAMHA have no authority to indemnify the Collaborator.

13.4 Force Majeure. Neither Party shall be liable for any unforeseeable event beyond its reasonable control not caused by the fault or negligence of such Party, which causes such Party to be unable to perform its obligations under this CRADA, and which it has been unable to overcome by the exercise of due diligence. In the event of the occurrence of such a force majeure event, the Party unable to perform shall promptly notify the other Party. It shall further use its best efforts to resume performance as quickly as possible and shall suspend performance only for such period of time as is necessary as a result of the force majeure event.

Article 14. MISCELLANEOUS

14.1 Governing Law. The construction, validity, performance and effect of this CRADA shall be governed by Federal law, as applied by the Federal Courts in the District of Columbia. Federal law and regulations will preempt any conflicting or inconsistent provisions in this CRADA.

14.2 Entire Agreement. This CRADA constitutes the entire agreement between the Parties concerning the subject matter of this CRADA and supersedes any prior understanding or written or oral agreement.

14.3 Headings. Titles and headings of the sections and subsections of this CRADA are for the convenience of reference only, do not form a part of this CRADA and shall in no way affect its interpretation.

14.4 Waivers. None of the provisions of this CRADA shall be considered waived by any Party unless such waiver is given in writing to the other Party. The failure of a Party to insist upon strict performance of any of the terms and conditions hereof, or failure or delay to exercise any rights provided herein or by law, shall not be deemed a waiver of any rights of any Party.

14.5 Severability. The illegality or invalidity of any provisions of this CRADA shall not impair, affect or invalidate the other provisions of this CRADA.

14.6 Amendments. If either Party desires a modification to this CRADA, the Parties shall, upon reasonable notice of the proposed modification or extension by the Party desiring the change, confer in good faith to determine the desirability of such modification or extension. Such modification shall not be effective until a written amendment is signed by the signatories to this CRADA or by their representatives duly authorized to execute such amendment.

14.7 Assignment. Neither this CRADA nor any rights or obligations of any Party hereunder shall be assigned or otherwise transferred by either Party without the prior written consent of the other Party.

14.8 Notices. All notices pertaining to or required by this CRADA shall be in writing and shall be signed by an authorized representative and shall be delivered by hand or sent by certified mail, return receipt requested, with postage prepaid, to the addresses indicated on the signature page for each Party. Notices regarding the exercise of license options shall be made pursuant to Article 8.2. Any Party may change such address by notice given to the other Party in the manner set forth above.

14.9 Independent Contractors. The relationship of the Parties to this CRADA is that of independent contractors and not as agents of each other or as joint venturers or partners. Each Party shall maintain sole and exclusive control over its personnel and operations. Collaborator employees who will be working at NIH/ADAMHA facilities may be asked to sign a Guest Researcher or Special Volunteer Agreement appropriately modified in view of the terms of this CRADA.

14.10 Use of Name or Endorsements. By entering into this CRADA, NIH/ADAMHA does not directly or indirectly endorse any product or service provided, or to be provided, whether directly or indirectly related to either this CRADA or to any patent or other IP license or agreement which implements this CRADA by its successors, assignees, or licensees. The Collaborator shall not in any way state or imply that this CRADA is an endorsement of any such product or service by the U. S. Government or any of its organizational units or employees.

14.11 Exceptions to this CRADA. Any exceptions or modifications to this CRADA that are agreed to by the Parties prior to their execution of this CRADA are set forth in Appendix D.

14.12 Reasonable Consent. Whenever a Party's consent or permission is required under this CRADA, such consent or permission shall not be unreasonably withheld.

Article 15. DURATION OF AGREEMENT

15.1 Duration. It is mutually recognized that the duration of this project cannot be rigidly defined in advance, and that the contemplated time periods for various phases of the RP are only good faith guidelines subject to adjustment by mutual agreement to fit circumstances as the RP proceeds. In no case will the term of this CRADA extend beyond the term indicated in the RP unless it is revised in accordance with Article 14.6.

15.2 Survivability. The provisions of Articles 4.2, 5.2, 5.3, 6.1, Articles 7-9, 11.3, 11.5, 12.1, 13.3 and 14.10 shall survive the termination of this CRADA.

NIH/ADAMHA Patent Policy Board April 24, 1989

CRADA SIGNATURE PAGE

FOR NIH/ADAMHA:

______________________________ ____________
Date

____

Mailing Address for Notices:

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____
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FOR THE COLLABORATOR:

______________________________ ____________
Date

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Mailing Address for Notices:

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[Include additional signature and address blocks as necessary for all Parties to this CRADA.]

NIH/ADAMHA Patent Policy Board April 24, 1989

APPENDIX A

NIH/ADAMHA POLICY STATEMENT ON COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS AND INTELLECTUAL PROPERTY LICENSING

[Insert the Policy Statement as Appendix A behind this page.]

NIH/ADAMHA Patent Policy Board April 24, 1989

APPENDIX B

RESEARCH PLAN

TITLE OF CRADA: ____
____.

NIH/ADAMHA PRINCIPAL INVESTIGATOR: ______________________
______________ and his/her Laboratory: ______________________
__________.

COLLABORATOR PRINCIPAL INVESTIGATOR: ____________________
______________________.

TERM OF CRADA: ___ ( ) years.

CONFLICTS OF INTEREST INFORMATION: Describe any relevant past, present or contemplated relationships between the NIH/ADAMHA Principal Investigator and his/her Laboratory and the Collaborator in sufficient detail to permit reviewers of this CRADA to determine whether or not any conflicts of interest exist: ____
____
____
______________.

The Research Plan which follows this page should be concise but of sufficient detail to permit reviewers of this CRADA to evaluate the scientific merit of the proposed collaboration. The RP should explain the scientific importance of the collaboration and the research goals of NIH/ADAMHA and the Collaborator. The respective contributions in terms of expertise and/or research materials of NIH/ADAMHA and Collaborator should be summarized. Initial and subsequent projects contemplated under the RP, and the time periods estimated for their completion, should be described, and pertinent methodological considerations summarized. Pertinent literature references may be cited and additional relevant information included. Include additional pages to identify the Principal Investigators of all other Parties to this CRADA.

APPENDIX C

FINANCIAL AND STAFFING CONTRIBUTIONS OF THE PARTIES

[Insert the Financial and Staffing Contributions as Appendix C behind this page.]

APPENDIX D

EXCEPTIONS OR MODIFICATIONS TO THIS CRADA

Mr. **Walgren**. Thank you very much.

Each of you come from some different perspectives, I gather, all except Dr. Brewen. We've heard the GAO say that some of the agencies have said that they have not had the legal expertise to develop an active, cooperative research arrangement. Has that been the experience in your particular Federal agencies? Is that a good reason, in your view, for a lack of involvement to date in this program?

Maybe I ought to address it to Dr. Schmid, and then if any others have any comments, you can feel free to make them.

Dr. **Schmid**. I can only report from what I gather from talking to the labs and agencies, since we're not a Government agency, per se.

I guess my impression is that if you want to stop from going into cooperative research agreements because you don't have the expertise to do it, that provides a reason. I think I tried to make the point that I see situations where the lack of regulations and so on are used as an opportunity to develop the procedures that are necessary to implement it. I think the Consortium provides a useful mechanism whereby we can help those people, without the right terms and clauses and that sort of thing, to get that from those who have that advice. And so that by networking and interacting with those that have the experience to do it, provide those that can gather the experience from those people.

Mr. **Walgren**. Well, it would seem that if you have a pretty extensive clearinghouse operation, there should be lots of legal models around to choose from, and little reason to say that they don't have the expertise within the agency to deal with that kind of thing.

Dr. **Schmid**. That's right. They have to be motivated, of course, to ask for that expertise. We are in the process of collecting various model sorts of agreements that we can provide people in those situations. The National Institute of Standards and Technology, of course, is a good example of having lots of different types of agreements related to partnerships and that sort of thing with industry, and they have made those available to us so that we can just, you know, give them out to others that would like to see them as well.

Part of our first model demonstration experiment, the one where by the law we're obligated to provide some funding for these demonstrations, that first one also provided, in a software way, related to licensing model sort of statements and so on. So there are mechanisms whereby that sort of information can be transferred as well.

Mr. **Walgren**. This effort is not new in—the Federal laboratory consortium has existed for 18 years. Certainly the Monmouth operation has been active for years, as has the agricultural groups.

Can you comment on any of the difficulties that prevented development in the past that still remain? What sort of—We've had some positive testimony about how things can happen. What are the difficulties that still face the development of more active, cooperative research in particular, I think. Mr. Stern, would you respond to that?

Mr. **Stern**. Yes. I think most of the barriers have been removed now. We have delegation of authority and we have interim guidelines. But one thing I see hovering in the future is not the lack of expertise in a legal counsel office but lack of personnel. We have a backlog of nearly a hundred invention disclosures just from our laboratory alone. We produce about 27 inventions—patents a year, and we have a backlog. We have three people on the legal staff. The average age is 61. So you can see what's going to happen in a few years, and there aren't new people coming into the legal for many different reasons, in the Government legal staff offices. So this is a problem that's going to come up.

Initially, we had to have a shift. It took a number of months for the legal staff to shift into the tech transfer mode, to put lawyers into this area of working on CRDA's and patent licensing and so forth and so on. That's well taken care of. But the lack of personnel and a worsening of that situation in the future is going to hamper us.

Mr. **Walgren**. Are there other comments on the difficulties that you still face in the Agricultural Service, NIH? I appreciate your having raised computer software and the inability, as I understand it, to copyright that. Is that a factor that you all would like to see brought under this umbrella? Is there any disagreement on that? And would that be felt to be a substantial activity?

Dr. **Adler**. Well, speaking for the NIH, it would be a very welcome addition to our technology transfer efforts.

If I might just mention, for us at NIH, it was very, very helpful to develop a policy statement that we distributed to industry as well as circulated in our own house, that explains positions on treatment of confidential information from companies, what time periods there are to publish the results of research, reviews for patentability matters as well, and that document, I think, has expedited our approval.

Just as a logistical matter, without these sort of standardized policies and forms, just to review individual documents crafted by the attorneys at numbers of outside companies takes a great deal of time and does so at different levels of review. So for us, it was almost—let me not exaggerated—it was very, very helpful to have a standardized form in terms of putting the word out about our policy and approaches to different matters.

Our rate-limited step, I think, was simply reviewing documents in the past.

Mr. **Walgren**. Thank you very much.

The Chair recognizes the gentleman from California, Mr. Campbell.

Mr. **Campbell**. Thank you, Mr. Chairman, and thank you for holding these hearings.

I have a question directed particularly to Dr. Adler and Mr. Stern, but the other panel members might be able to comment on it. I've spent a fair amount of time dealing with the consortium issue from the point of view of high technology in particular. My district represents Silicon Valley and EPRI, in particular. And the following scenario has been described to me. I wonder if you could tell me whether it's been true in your experience or not.

And that is that some consortia get the second-best idea from independent industry, not their first-best idea. That is to say, not the ideas you develop on your own, but those that come in from commercial industry might be not the very first best because of the risk that, if it is given to a consortium, it would then have an obligation to be shared with other companies, and they might lose the advantage of the market-leading technology. Whereas the second-best idea, fine. If they get a free ride, somebody else develops it, we'll all share in it.

This scenario intrigues me, and I'll address it particularly to Dr. Adler, because it was described to me as being true in the area of AIDS research, that some pharmaceutical companies were holding back on what might be their very most prominent idea because, much as everyone would like to see a cure for that disease as quickly as possible, there is a commercial aspect that you don't want to give your absolute best idea to somebody who might then beat you to the commercialization of it.

All right. That has been described to me. It's an intriguing theoretic possibility. I would like to have your insight as to whether it's a realistic fact.

Dr. ADLER. I can't give you statistics on that, but I can respond somewhat anecdotally. For some companies, the CRADA research project is essentially all the research the company does, and this tends to be some of the smaller, biotechnology companies or newer companies. For some of the larger companies, I don't believe that the quality of our collaborative research project is a second-tier project, but it may or may not be the crown jewel research project of the company. And there is a fear on the part of many companies, particularly expressed by the Pharmaceutical Manufacturers Association, for instance, that relates to the rights and inventions that are retained by the Government.

The FTTA talks about reserving the right of a non-exclusive, royalty free, worldwide license for Government purposes, and some of the companies are concerned that this language has not been well characterized in the courts or the legislative history, and they, frankly, are a little bit leery about entering into a project with an agency that also funds health care and is concerned about pricing, et cetera, when there is somewhat of a nebulous grant of rights that the Government reserves.

Mr. CAMPBELL. Thank you.

Mr. Stern, do you have any observation on that point?

Mr. STERN. No, not really. We don't have that second-best situation. A lot of the companies we deal with are small businesses initially and we get good innovators there and we don't have that situation, really.

Mr. CAMPBELL. I take it your members would be more like the first group that Dr. Adler described—

Mr. STERN. Yeah.

Mr. CAMPBELL. —those who view your consortium as the way in which they'll do research.

Mr. STERN. Right.

Mr. CAMPBELL. Fine.

The context in which I had this described to me was the second group that Dr. Adler identified, where you have a large company that could do its own research as well and chose to put particular projects into a consortium and withhold others.

Would the other doctors have any comment on this?

Dr. BREWEN. I would like to make a comment on two points. One, the concept of the second-best idea, our consortium, of course, is unique in the sense that we're going to the Federal laboratory and we're also going to the State universities and we're looking for their crown jewel ideas. But it became very apparent to me, and it would be apparent to anyone who ever sat in on some of our meetings, that there are research proposals that are on occasion recommended to us, in which certain member companies reflectively back away from, and it's obvious what those reasons are. And so it is a potential problem.

I don't think the problem is associated with a sharing of a base technology, because I think most of the major companies, certainly the ones that are involved in our consortium, feel confident enough that if given a basic technology, they can outrun their competitors, including their fellow members. There is certainly an ego factor involved here.

The concern is—two things. The public—The Freedom of Information Act, and the fact that that apparently, at least based on my limited experience, is not universally interpreted as to what you can release and to what degree we, for example, BRDC, if we enter into an agreement with a Federal laboratory, have the right to request a sanitization of what is released, so that some of our best research ideas aren't going out to the competitors. And then the other point, again, that Dr. Adler made, there is concern on some of our member companies of the ill-defined rights that the Government retains in any research and technology that is developed under these joint cooperative research agreements.

Mr. CAMPBELL. Mr. Chairman, in view of the imminent vote, I will yield back my time. But I do just want to thank the panel and note for the Chairman's interest—I'm sure you share with me that—I picked up some very insightful points from this panel, particularly on the prospects of FOIA and the prospects of a royalty-free license obligation, which might cause less than the optimal amount of participation in the consortium that we would like. But I yield back my time. Thank you.

Mr. WALGREN. I thank the gentleman.

The Chair recognizes the gentlelady from Maryland, Mrs. Morella.

Mrs. MORELLA. Thanks, Mr. Chairman, and I also appreciate the panel being here, and I'll talk fast because we have to go and vote.

But I'm honored to represent the district that includes the National Institutes of Health and includes NIST, where you've got so much of the technology transfer agreements that are taking place. And I'm curious, since there seems to be a downside to everything, why, when we talk about the need for intellectual property rights and software, what's the downside on that? Maybe Dr. Adler, anyone who wants to comment on that. It seems like such a natural thing to do, and I know the committee is looking into it.

Dr. ADLER. I'm not really aware of a downside in the case of technology-oriented software, things that have commercial value. As I understand the copyright provisions, originally the Government wasn't in the business of creating technologically useful software and the policy was to make the results of Government work publishable freely and copiable by everyone. I think the times perhaps have changed a little bit, and I frankly don't see a downside at the present time in this area.

Mrs. **Morella**. I just wondered why it hadn't been done sooner, why we were now looking at doing that?

Also, in your testimony, Dr. Adler, on page 15, I was trying to figure out a sentence under 2, the very last few sentences, "...unpatentable research material is not licensed to industry, although most universities actively license such technology." But it really links up with the sentence before that, which says "Because the FTTA appears to authorize only the licensing of intellectual property rights, the Patent Policy Board has not permitted the licensing of technology generally."

Can you explain what that means?

Dr. **Adler**. Well, the Technology Transfer Act, which refers to transfer of technology in some of the broad policy statements about transferring technology, include a universe of research results, a subset of which are inventions or patent applications. So in terms of moving useful technology generically to industry, this includes biological materials that may not be patentable. The specific authorization in the FTTA speaks to licensing of patent rights. So that universities that might develop a virus, for instance, or a cell line useful for screening compounds, can license a cell line or a virus or a test tube. We have interpreted FTTA to grant us the right to license a patent application.

Mrs. **Morella**. I see.

A question probably to Dr. Schmid. Has there been any attempt to distribute this so-called model policy to other labs so that they could follow it?

Dr. **Schmid**. Yes. And, in fact, a lot of that occurs in training sessions, which are at the request of our members, on targeted sorts of things. For example, at our last national meeting, there was a training session on Cooperative Research and Development Agreements. Some of the experience that the panel members here have had in that area were presented as part of that training.

Mrs. **Morella**. (Presiding.) Can you mention some of the agencies?

Dr. **Schmid**. Some of the agencies that have participated in the training have been like the Army, the agricultural—the people here on this panel.

Mrs. **Morella**. So the major agencies that have been involved in technology transfer agreements that, you know—

Dr. **Schmid**. Right, and, of course, those who are receiving that sort of information are many of our other member laboratories from other agencies, like the Department of Energy, Air Force, National Science Foundation, those sorts of groups.

Mrs. **Morella**. Do you have plans to expand?

Dr. **Schmid**. Yes. That has been through some of the surveys that we've conducted of our members, is training has been one of the aspects that they did want us to enlarge our efforts on.

Mrs. **Morella**. Dr. Adler, how has the industry reacted to the NIH guidelines? I mean, what kinds of questions have come up?

Dr. **Adler**. The preeminent question which came up with an earlier draft of the guidelines related to the kinds of rights that the Government would retain in inventions made solely by employees of the collaborating company. Originally, our language in the policy guidelines repeated the reservation of rights as would be required for inventions made by Government employees under the FTTA or under the patent law. That was the primary source of concern. We ended up changing the types of reserved rights to rights for research purposes for inventions made solely by collaborators.

The issue of retained rights, I think, was the largest concern.

Mrs. **Morella**. Dr. Stern, can you tell us more about how you put together the CRDA teams? I mean, how do you select the research areas? Do you go out and solicit industry participation?

Mr. **Stern**. Well, we have been working in technology transfer over the years. This is just an enhancement, a strengthening really of technology transfer. In our particular niche of electronics, we have been working in-house on these things, on these projects in electronics, and also through contracts, and we're in intimate contact with universities and academia and with industry in our particular area and we know the field. We have been working—networking with these people for years, so really, unofficially, we have been doing technology transfer without the Act ever since, and we're just enhancing that situation now, where we can bring these people into work officially with our people, and it was really a very smooth transition, something that really was going on. It's just an enlargement, enhancement of what we have been doing in the past. We're just formalizing it.

Mrs. **Morella**. Dr. Schmid, I guess one last question, and then I've got to run off and vote.

I wondered about your relationship with the States, and then probably as a second part to the question, a little bit more about the draft agreement that you have with NIST.

Dr. **Schmid**. Okay. We've conducted a couple of demonstration experiments with the States. One was the vocational education group in Oklahoma, where we worked with them on a process similar that we—but modified—that we have used with large industries, where we use them as a service group to get together with the small businesses and use that service organization as a mechanism to interact with the small businesses.

In the case of NIST, we have a draft agreement where we would support them in their technical extension service work in terms of outreach efforts to the service organization in the various States, giving them information on how to better access the expertise and capabilities that are available in the laboratories. We've been involved with them in their planning for a clearinghouse in some of the studies that they're doing in that area. We look forward to these sort of mechanisms to better reach the small businesses in the States.

Another experience we had was out in California with NASA's Industrial Applications Center, where linking with that particular network, we made available not only the information resources that NASA has, but also the other Federal laboratory technologies where the small businesses can go to the Small Business Development Centers in 15 States and, through that mechanism, then get into the NASA network as well as the full Consortium network.

Mrs. **Morella**. I want to thank you very much for your response. I want to thank the entire panel for appearing before us. Please know that we sometimes have three meetings going on simultaneously, so that members of the subcommittee do, in fact, read the testimony. We may have a few questions to submit to you for the record. But on behalf of the Chairman and the Subcommittee, I want to thank the panel.

When the Chairman comes back, he's going to start with Panel 3. Thank you very much for what you are doing for our country.

[Whereupon, the subcommittee was in recess.]

Mr. **Walgren**. (presiding.) Let me call us to order again, if I might, and call the third panel. As you know, we are operating under a deadline this morning, when we will have an interruption for the services for Senator Pepper that we certainly will hold to. But if we are efficient about it, I think we can get the testimony that each of you has to give, certainly in some full summary form, into the record, and then, if there are points that the Committee would like to raise with you, we could raise them in writing.

So let me introduce for the record Dr. George Millburn, Deputy Under Secretary of Defense, with the Research and Advanced Technology group; George Singley, Director, Research and Technology, with the Office of the Secretary of the Army; Richard Rumpf, the Acting Assistant Secretary of Navy for Research and Engineering and Systems; and General John Douglass, the Acting Director for Science and Technology with the Office of the Assistant Secretary of the Air Force for Acquisition.

Gentlemen, welcome to our proceedings. We have a—If you could shoot for five minutes each, I think we can meet the deadlines that we have to. So let's go through your testimony in the order in which I introduced you to the record, and start with Dr. Millburn.

STATEMENTS OF GEORGE P. MILLBURN, DEPUTY DIRECTOR, DEFENSE RESEARCH AND ENGINEERING (RESEARCH AND ADVANCED TECHNOLOGY), U.S. DEPARTMENT OF DEFENSE; GEORGE T. SINGLEY, III, DIRECTOR, RESEARCH AND TECHNOLOGY, OFFICE OF THE ASSISTANT SECRETARY OF THE ARMY (RESEARCH, DEVELOPMENT AND ACQUISITION); RICHARD L. RUMPF, ACTING ASSISTANT SECRETARY OF THE NAVY (RESEARCH, ENGINEERING AND SYSTEMS); AND BRIGADIER GENERAL JOHN DOUGLASS, DIRECTOR OF SCIENCE AND TECHNOLOGY, ASSISTANT SECRETARY OF THE AIR FORCE FOR ACQUISITION

Dr. **Millburn** Thank you, Mr. Chairman. I am very happy to be here, and with your permission, I will summarize the statement I have submitted for the record.

First I would like to comment on some of the discussion I heard this morning about the fraction of research and development work that's done in the Department. Of the total of approximately 40 billion dollars that's spent in RDT&E, only about six or seven billion dollars, depending on how much we account for the SDIO, actually goes into the science and technology program, which I believe is of primary interest in the technology transfer function. The rest goes into development of specific weapons systems and their testing and their evaluation.

I want to say that the Department is a firm and very enthusiastic supporter of the technology transfer efforts. We have our DOD regulation in effect which requires adherence to the Federal Technology Transfer Act of 1986, and Executive Order 12591. I believe that the Department has a long history of successful technology transfer from defense fields to commercial applications. Perhaps the most outstanding is in the aircraft industry, particularly the development of the jet engines which throughout the years has kept the United States in the forefront of that field.

Materials developments. Also, we have a carbon-carbon material that we developed primarily for use in rocket nozzles. It's now being applied by the commercial firms as brake pads for jetliners. They get two to three times as many landings per brake pad as they used to.

Similarly, historically radio navigation developed by the Defense Department has been widely used in the new global positioning system and it will introduce a whole new capability in that field. In the field of integrated circuits, computers, lasers and the like, we have been, of course, in the forefront.

A very interesting possibility in the future is a red blood cell substitute that is being developed by the Navy. If this proves out to be effective, it's certainly going to be very, very useful in the civil field as well as in the military field.

Again, I believe an important area is in training and testing. The Department of Defense probably sponsors and spends more money on training than any other agency in the world, and most of this is readily available to the private sector and has been used very effectively.

In the past we have depended upon our industries to do the technology transfer. About—approximately 75 percent of the total R&D program in the Department is performed by private industry, and we have looked to them to expedite the transfer. Now we're becoming more proactive as a result of the Technology Transfer Act of 1986.

In addition, we have a university research initiative, and in that we have a research initiative program which favors joint efforts between the laboratories, the universities, and other civil endeavors.

We have a policy of releasing all DOD reports which are not restricted for security reasons to the National Technical Information Service, and these are available for purchase by the private sector.

We are in the process of developing a database of areas of technical expertise in our laboratories so that we can refer commercial inquiries to the proper expert within the laboratories.

Just in summary, I would like to say that we firmly believe that the national security requires a strong national economy. The DOD research and development program has provided valuable spinoffs for commercial application, and we are prepared to work with Congress, other Executive branches and industry, to maximize spinoff benefits of our research in order to strengthen the United States competitiveness.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Millburn follows:]

Hold Until Released
By the Committee

DEPARTMENT OF DEFENSE

STATEMENT ON DOMESTIC TECHNOLOGY TRANSFER

BY

DR. GEORGE P. MILLBURN
DEPUTY DIRECTOR DEFENSE RESEARCH AND ENGINEERING
(RESEARCH AND ADVANCED TECHNOLOGY)

TO THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
OF THE
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
101ST CONGRESS, FIRST SESSION

JUNE 1, 1989

Good morning. I am pleased to be able to appear before your Subcomittee in order to describe the role of research and development (R&D) within the Department of Defense (DoD) and its relation to domestic technology transfer.

The Department conducts an agressive R&D program to maintain U.S. defense capabilities at the leading-edge of technology so that our scientists, engineers, and the manufacturing community can design and produce military weapons systems at the highest level of efficiency and effectiveness. A key element of U.S. defense strategy in weapons development is to promote R&D for the purpose of weapons superiority in order to balance large numerical imbalances.

To accomplish our national security goals the R&D program is carried on by industry, universities, National Laboratories, Service laboratories, and other organizations such as the National Institutes of Standards and Technology. While the private sector performs about 75 percent of DoD's R&D, there is no arbitrary policy on organizational distribution, and selections are made in order to best achieve technical goals. We routinely organize teams within industry or among industry, universities and other laboratories. When there are common interests we jointly fund activities with other parts of the Government, such as the Department of Energy (DoE) or the National Aeronautics and Space Administration (NASA).

We are sensitive to the need to maintain a strong university community. Our research activities at colleges and universities provide both salaries and dissertation support for many students, particularly in the sciences and engineering. Our support of research programs is an essential element of the intellectual thread necessary to weave a strong technology base in the U.S. We strongly support the belief that students and faculty at colleges and universities have not only the right but an obligation to disseminate their research findings throughout the scientific community, so the vast majority of our work at those institutions is totally unclassified.

Before explaining the overall basis of DoD's domestic technology transfer activities it is important to establish some facts about the Department's funding of R&D. The basic research or 6.1 programs are funded at $955 million. The exploratory development or 6.2 programs (the analogue of applied research) are funded at $2.5 billion. Advanced technology development or 6.3A programs are funded at $2.3 billion. These three budget categories equate the 15 percent of the total DoD R&D investment. This does not include the Strategic Defense Initiative activities. The remaining funds in budget categories 6.3B through 6.5 involve design, engineering, testing and evaluation of specific weapons systems. The emphasis on development is essential if the RDT&E program is to accomplish its principal purpose, the realization of new technologies in state-of-the-art military hardware. DoD is unique among federal agencies in the emphasis on systems development. This reflects the Administration policy to limit Federal support for development to areas such as Defense. In other areas product development is appropriately supported by the private sector.

DoD plays a modest role in Federally supported research, providing about 9 percent of the total Federal support for basic research and about 25 percent of Federal funding for applied research. DoD is dominant in Federal support for development, accounting for 83 percent of the total. These are FY 1989 figures.

Much of the R&D supported by the Department is so-called dual use technology, applicable to both Defense needs and commercial requirements. Most of that work is unclassified. While some of the companies that receive DoD R&D support concentrate their sales in the defense sector, many others are active in both defense and commercial arenas, e.g. International Business Machines (IBM), American Telephone and Telegraph (AT&T), General Electric (GE), General Motors (GM), Ford, Boeing, Texas Instruments (TI), Westinghouse, Xerox, and many others. Eight out of the top ten DoD contractors have significant commercial activities. Dual use technology developed for DoD at those firms inevitably affects both their defense and commercial products. This is probably the most effective mechanism for rapid and efficient domestic technology transfer.

The Department's current policy structure and activities in implementing the DoD domestic technology transfer program are pertinent. The program is based upon the Stevenson-Wydler Technology Innovation Act of 1980, the amendments to Stevenson-Wydler incorporated by the Federal Technology Transfer Act of 1986, and the President's Executive Order 12591 on "Facilitating Access to Science and Technology" of April 10, 1987. The Department's current policy directive fully implemented the provisions of those statutes and the Executive Order. The Federal Technology Transfer Act grants direct statutory authority to the Departments of Army, Navy, and Air Force to execute the programs. As a result the DoD policy directive establishes a broad framework for the Department and prescribes Department-wide policy where consistency of approach is warranted. Within that policy structure, the Military Departments have defined their implementations of the program within their organizational and operational frameworks. Their testimony will explain their program to you. The principle elements of the DoD program are:

1. DoD policy provides for a full-time equivalent position for an Office of Research and Technology Application (ORTA) at each laboratory with at least 200 scientific,

engineering, and technical personnel. In addition, many other DoD laboratories have established similar capabilities to support their program activities in these areas.

2. DoD laboratories have always had active patenting and licensing programs. In FY 1987, DoD laboratories received 602 patent awards and submitted an additional 504 patent applications for DoD developed technologies. Since the majority of the DoD R&D program is conducted by contractors and grantees, the full innovative impact of DoD-funded R&D is much greater than the above figures. In this regard, our procurement contracts permit our contractors to patent, license, and commercially market technology they initially develop at government expense subject to reservation by the Government of a nonexclusive, irrevocable, paid-up license for Government use of the invention.

3. DoD has initiated several policies that recognize individual inventors in technical areas of interest. These inventors have both a strong professional and personal interest in seeing technology that they have developed used in a broad and expeditious manner. We provide for sharing of royalties with Government employees who participate in patented inventions that are licensed for commercial use. The Government inventor receives 20 percent of the Government royalties on an annualized basis. We have directed the DoD Components to establish and promote appropriate recognition of inventors through monetary

and professional excellence awards for all materially significant contributions to the objectives of domestic technology transfer. If the Government elects not to pursue potenting and/or licensing of an invention, the Government inventor has the first right to apply for the patent and license rights. We have directed the Military Departments to develop criteria, guidelines, and timeframes to implement this policy. This will permit the individual inventor to pursue commercial opportunities where the government elects not to invest in the processing of patent applications.

4. In the area of establishing and utilizing university research centers, there is a related activity we have undertaken. Under the University Research Initiative (URI) the university community conducts research in areas of DoD interest. At the same time these research activities have the potential of fostering commercial applications. Similar opportunities arise from the technology base activities of the DoD Small Business Innovative Research (SBIR) Program.

5. Executive Order 12591, Section 5, prescribes that DoD shall identify a list of funded technologies that would be potentially useful to U.S. industries and universities. Determination of the commercial potential and the commercial application of DoD funded R&D is best undertaken by the private sector. Therefore, the DoD approach is to provide for the widest possible dissemination of Defense R&D subject to

reasonable restrictions for reasons of national security, export, and related matters.

R&D is documented in the form of technical reports. This information is centrally collected, announced, and released for public purchase through the National Technical Information Service (NTIS) at the Department of Commerce unless it is restricted for release for purpose of national security. In FY 1988, over 16,200 technical reports were provided by DoD to NTIS for public release and purchase. In a related knowledge transfer effort, DoD is developing a data base on areas of expertise within DoD laboratories. With the help of this data base, we will be able to refer inquiries from the domestic sector to appropriate experts in DoD laboratories. This referral system will facilitate the personal interaction that will allow exploration of the potential for commercializing technologies under development in DoD laboratories. All DoD patents are described in an annual catalog of Federal patents issued by the NTIS. In addition to the description, the catalog provides points of contact for the pursuit of licensing opportunities. In a more focused manner, many DoD laboratories directly interact with economic development groups at regional, state, and local levels.

Another approach is the Navy's Domestic Technology Transfer Fact Sheet. This monthly publication describes recent technical innovations and explores their commercial application potential in a newsletter format. With over 8,000 subscribers for this monthly bulletin, many of which are in the private sector, it provides a constantly current medium to disseminate technologies with commercial potential.

6. Engaging in cooperative research and development agreements (CRDA's) is an active effort in DoD. Forty-five (45) CRDA's are in place or in negotiation at this time. They encompass a broad range of technical areas and include both the private sector and university participants. The DoD has no significant problems in implementing the provisions embodied in the Federal statutes or Executive Order 12591 in this area.

The majority of DoD's R&D is accomplished by contractors. Technology advances developed to meet DoD mission needs routinely result in corollary commercial activities. The U.S. aircraft industry is often described as the classic example of this synergistic effect. Past spin-offs to the commercial sector from high risk dual use research supported by DoD have played a major role in U.S. economic strength. In the computer industry, for example, DoD supported efforts have led to computer time sharing, computer graphics applied to such areas as computer aided design and biotechnology, and computer aided instruction.

DoD has supported the field of materials science in areas such as ceramics and ceramic composites, microelectronics materials, metal alloys and rapid solidification, and advanced polymers. Modern materials coming out of DoD research are found in diesel and gasoline powered automobiles, sporting goods, medical prosthetic implants, and many other products of U.S. companies.

Commercial application of Defense R&D is an on-going process. Recent research conducted by the Navy in synthetic red blood cells shows great promise. The goal of assuring a supply of disease free blood cells is of great significance from both a military and civilian perspective.

Another innovative effort is a program initiated by the Army Corps of Engineers. Through its civil works authority, the Corps sought and received Congressional approval to engage in cost shared cooperative R&D for construction purposes. As the Federal Government's executive agent the Corps is one of the largest purchasers of general purpose commercial type construction in the U.S. As concluded in a study by the National Research Council of the National Academies of Science and Engineering in late 1986, the U.S. construction industry is in the bottom tier of R&D investment of mature industries in the U.S. at a level of 0.39 percent of revenues. The highly fragmented, highly competitive nature of the construction industry compared to a much more concentrated industry in other countries has a serious impact in the U.S. industry's ability to compete at home and abroad.

This Army effort identified as the "Construction Productivity Advancement Research" program provides for up to 50 percent cost sharing of projects with $3 million in FY 1989 funds. The Corps has received 145 proposals from a mix of large and small businesses, universities and colleges, state and local governments, and trade associations. The proposals cover a wide-range of applications including hardware, machinery, robotics, materials, and software.

In response to questions or potential legislative issues raised by the Committee in the last year, three areas need to be addressed. Questions from the Committee concerning the impact on domestic technology transfer of the Freedom of Information Act (FOIA) and Government conflict of interest statutes and regulations have been addressed. Also the potential need to copyright intellectual property generated in-house by the Government (particularly computer software) has been examined. From the standpoint of domestic technology transfer activities, we have not identified a need to modify either the FOIA or conflict of interest statutes. Many questions of interpretation and perception continue to be raised. These statutes require careful consideration of the Government's actions. The sensitivities of both areas mandate great care. We do not know if these statutes are considered an impediment by commercial interests as they attempt to deal with the Federal Government. The area of Government copyright of intellectual property, while excluded from the domestic technology transfer arena, has been raised by industry, the Congress, and Government laboratoriess as an area worthy of examination. The commercial value of computer software is certainly recognized by the private sector, as are other forms of intellectual property. Examples include areas such as vocational training materials and shock trauma procedures that are of interest to both DoD and the private sector. Although DoD has no specific concerns at this time, the public policy issue of allowing for protection of Government generated intellectual property deserves careful consideration. A means should be sought to provide needed incentive to the private sector to undertake the development of Government generated computer software into a commercial product. Public access versus commercial value can raise some difficult issues.

The Department of Defense recognizes that national security is closely tied to economic strength. We believe that investment in DoD R&D has provided an excellent return for the Nation. We are prepared to work with the Congress and industry to maximize the spin-off benefits of our research in order to strengthen U.S. competitiveness.

Mr. **Walgren**. Thank you, Dr. Millburn.

And we will turn then to Mr. Singley.

Mr. **Singley**. Good morning, Mr. Chairman.

I am pleased to appear before this distinguished subcommittee today to describe the Army domestic technology transfer program which is increasing private sector use of Army laboratory research and development products, speeding technology spinoff to the private sector, enhancing United States competitiveness, and providing valuable technical assistance to both local governments and the public education sector.

The Army domestic technology transfer program encompasses 36 Army laboratories and research, development and engineering centers, each with an Office of Research and Technology Applications, referred to earlier as ORTA, to perform technology transfer functions including those specified in Public Law 96-480, as amendment by Public Law 99-502.

The Army program operates through the decentralized but coordinated activities of these offices. Active participation in the Federal Laboratory Consortium by each ORTA has been required by Army Regulation 70-57 since 1983. Each ORTA markets Federal laboratory technology transfer services, laboratory technology for industrial application, and laboratory expertise for technical assistance.

Prior to the passage of the Federal Technology Transfer Act of 1986, Army Regulation 70-57 established in 1983 a domestic technology transfer program implementing the provisions of the original Stevenson-Wydler Act, directing the establishment of an ORTA at each of the 36 identified laboratories, making the Army Materiel Command responsible for coordination of laboratory programs Army-wide, and requiring all identified laboratories to participate in the FLC.

In fiscal year '87, subsequent to the issuance of Executive Order 12591, the Secretary of the Army delegated the new authorities to the Assistant Secretary of the Army for Research, Development and Acquisition, who then appointed a program manager for domestic technology transfer, and in 1988 redelegated the authorities to enter into Cooperative R&D Agreements and Patent License Agreements to the commanders of the major commands.

This delegation included authority for further delegation to their subordinate elements, and was accompanied by a letter requesting aggressive, decentralized implementation of the law. In particular, Army laboratory commanders and directors were directed to ensure that their ORTAs were staffed to meet the requirements of the law. Agency actions were taken to strengthen the implementation of the law. Interim guidelines were issued for handling of CRDAs and the Patent License Agreements. Revision of the domestic technology transfer regulation was initiated to provide final Army policy in conformance with the law and the Executive Order.

The domestic technology transfer programs of the Army commands and their individual laboratories are innovative and reflect the diverse nature of the technology developed by the labs, as well as their size. Most of the ORTAs perform outreach activities to market potential dual use technology, form cooperative agreements in their areas of expertise, license their existing technology, and provide technical assistance to appropriate respondents. The Army Corps of Engineers, for example, has aggressively launched several initiatives with the construction industry.

All 36 Army FLC representatives respond to inquiries and referrals made through the network. In addition to national FLC activities, all Army labs provide input to the DOD database of technologies available for transfer. For example, in fiscal year '88, there were 4500 Army reports. During the past year, at least seven Army labs participated in exhibits of available technology at national meetings of professional societies or industry-oriented organizations aimed at technology transfer.

More than one-third of the individual Army labs have active outreach programs in their region, state and local areas, and this number is growing. Army labs are involved with state economic development programs in Illinois, Massachusetts, Maryland, New Jersey and Virginia.

Army labs also provide technical information to state and local governments ion areas such as concrete construction, mapping, water pollution control, controlling hazardous spills, and police communications. The Harry Diamond Laboratory's Technical Volunteer Service provides volunteers to assist local government and science and technology educational institutions in two adjacent counties. Because quality science and technology is vital to both our Nation's defense and our national competitiveness, the Army encourages such innovative programs.

Until the passage of Public Law 99-502, technology transfer activity focused on the transfer of technical information with often undocumentable payoff. Subsequently, the Army has completed 15 CRDAs and two PLAs with private companies, and other agreements are in negotiation at this time.

In summary, the Army has made significant technology contributions to the civilian sector such as laser surgery, freeze-dried food, rotorcraft technology, construction engineering, and photolithography for making integrated circuits. The Army is a leader in technology transfer as evidenced by being among the founders of the Federal Laboratory Consortium, having a supportive regulation since 1976, which was revised in '83, using technical volunteers to help improve science and technology education, and rapidly implementing cooperative research development agreement legislation.

We appreciate your support for the domestic technology transfer program which we believe is making a significant contribution to the strengthening of both our economy and our Nation's defense.

Thank you, sir.

[The prepared statement of Mr. Singley follows:]

DEPARTMENT OF THE ARMY

STATEMENT OF DOMESTIC TECHNOLOGY TRANSFER

BY

GEORGE T. SINGLEY III

DIRECTOR, RESEARCH AND TECHNOLOGY,
OFFICE OF THE ASSISTANT SECRETARY OF
THE ARMY (RESEARCH, DEVELOPMENT AND ACQUISITION)

TO THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
OF THE
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
101st CONGRESS, FIRST SESSION

JUNE 1, 1989

GOOD MORNING. I AM PLEASED TO APPEAR BEFORE THIS DISTINGUISHED SUBCOMMITTEE TO DESCRIBE THE ARMY DOMESTIC TECHNOLOGY TRANSFER PROGRAM WHICH IS INCREASING PRIVATE SECTOR USE OF ARMY LABORATORY RESEARCH AND DEVELOPMENT PRODUCTS, SPEEDING TECHNOLOGY SPIN-OFF TO THE PRIVATE SECTOR, ENHANCING U.S. COMPETITIVENESS, AND PROVIDING VALUABLE TECHNICAL ASSISTANCE TO LOCAL GOVERNMENTS AND PUBLIC EDUCATION.

THE ARMY DOMESTIC TECHNOLOGY TRANSFER PROGRAM ENCOMPASSES 36 ARMY LABORATORIES AND RESEARCH, DEVELOPMENT AND ENGINEERING CENTERS, EACH WITH AN OFFICE OF RESEARCH AND TECHNOLOGY APPLICATIONS (ORTA) TO PERFORM TECHNOLOGY TRANSFER FUNCTIONS INCLUDING THOSE SPECIFIED IN PL 96-480 AS AMENDED BY PL 99-502. THE ARMY PROGRAM OPERATES THROUGH THE DECENTRALIZED BUT COORDINATED ACTIVITIES OF THESE OFFICES. ACTIVE PARTICIPATION IN THE FEDERAL LABORATORY CONSORTIUM (FLC) BY EACH ORTA HAS BEEN REQUIRED BY ARMY REGULATION 70-57 SINCE 1983. EACH ORTA MARKETS FEDERAL LABORATORY TECHNOLOGY TRANSFER SERVICES, LABORATORY TECHNOLOGY FOR INDUSTRIAL APPLICATION, AND LABORATORY EXPERTISE FOR TECHNICAL ASSISTANCE.

PRIOR TO THE PASSAGE OF THE FEDERAL TECHNOLOGY TRANSFER ACT OF 1986 (PL 99-502), ARMY REGULATION 70-57 ESTABLISHED IN 1983 A DOMESTIC TECHNOLOGY TRANSFER PROGRAM IMPLEMENTING THE PROVISIONS OF THE ORIGINAL STEVENSON-WYDLER ACT; DIRECTING

THE ESTABLISHMENT OF AN ORTA AT EACH OF 36 IDENTIFIED LABORATORIES; MAKING THE ARMY MATERIEL COMMAND RESPONSIBLE FOR COORDINATION OF LABORATORY PROGRAMS ARMY-WIDE; AND REQUIRING ALL IDENTIFIED LABORATORIES TO PARTICIPATE IN THE FLC.

IN FY87, SUBSEQUENT TO THE ISSUANCE OF EXECUTIVE ORDER 12591, THE SECRETARY OF THE ARMY DELEGATED THE NEW AUTHORITIES TO THE ASSISTANT SECRETARY FOR RESEARCH, DEVELOPMENT AND ACQUISITION, WHO THEN APPOINTED A PROGRAM MANAGER FOR DOMESTIC TECHNOLOGY TRANSFER, AND REDELEGATED THE AUTHORITIES TO ENTER INTO COOPERATIVE R&D AGREEMENTS (CRDAs) AND PATENT LICENSE AGREEMENTS (PLAs) TO THE COMMANDERS OF THE MAJOR COMMANDS.

THIS DELEGATION INCLUDED AUTHORITY FOR FURTHER DELEGATION TO THEIR SUBORDINATE ELEMENTS, AND WAS ACCOMPANIED BY A LETTER REQUESTING AGGRESSIVE, DECENTRALIZED IMPLEMENTATION OF THE LAW. IN PARTICULAR, ARMY LABORATORY COMMANDERS AND DIRECTORS WERE DIRECTED TO ENSURE THAT THEIR ORTAs WERE STAFFED TO MEET THE REQUIREMENTS OF THE LAW. AGENCY ACTIONS WERE TAKEN TO STRENGTHEN THE IMPLEMENTATION OF THE LAW. INTERIM GUIDELINES WERE ISSUED FOR HANDLING OF CRDAs AND PLAs. REVISION OF THE DOMESTIC TECHNOLOGY TRANSFER REGULATION WAS INITIATED TO PROVIDE FINAL ARMY POLICY IN CONFORMANCE WITH THE LAW AND THE EXECUTIVE ORDER.

THE DOMESTIC TECHNOLOGY TRANSFER PROGRAMS OF THE ARMY COMMANDS AND THEIR INDIVIDUAL LABORATORIES ARE INNOVATIVE AND REFLECT THE DIVERSE NATURE OF THE TECHNOLOGY DEVELOPED BY THE LABS, AS WELL AS THEIR SIZE. MOST OF THE ORTAs PERFORM OUTREACH ACTIVITIES TO MARKET POTENTIAL DUAL USE TECHNOLOGY, FORM COOPERATIVE AGREEMENTS IN THEIR AREAS OF EXCELLENCE, LICENSE THEIR EXISTING TECHNOLOGY, AND PROVIDE TECHNICAL ASSISTANCE TO APPROPRIATE RESPONDENTS. THE ARMY CORPS OF ENGINEERS, FOR EXAMPLE, HAS AGGRESSIVELY LAUNCHED SEVERAL INITIATIVES WITH THE CONSTRUCTION INDUSTRY.

ALL 36 ARMY FLC REPRESENTATIVES RESPOND TO INQUIRIES AND REFERRALS MADE THROUGH THE NETWORK. IN ADDITION TO NATIONAL FLC ACTIVITIES, ALL ARMY LABS PROVIDE INPUT TO THE DOD DATA BASE OF TECHNOLOGIES AVAILABLE FOR TRANSFER. DURING THE PAST YEAR, AT LEAST SEVEN ARMY LABS PARTICIPATED IN EXHIBITS OF AVAILABLE TECHNOLOGY AT NATIONAL MEETINGS OF PROFESSIONAL SOCIETIES OR INDUSTRY ORIENTED ORGANIZATIONS AIMED AT TECHNOLOGY TRANSFER.

MORE THAN ONE-THIRD OF THE INDIVIDUAL ARMY LABS HAVE ACTIVE OUTREACH PROGRAMS IN THEIR REGION, STATE AND LOCAL AREAS, AND THIS NUMBER IS GROWING. ARMY LABS ARE INVOLVED WITH STATE ECONOMIC DEVELOPMENT PROGRAMS IN ILLINOIS, MASSACHUSETTS, MARYLAND, NEW JERSEY AND VIRGINIA.

ARMY LABS ALSO PROVIDE TECHNICAL INFORMATION TO STATE AND LOCAL GOVERNMENTS IN AREAS SUCH AS CONCRETE CONSTRUCTION, MAPPING, WATER POLLUTION CONTROL, CONTROLLING HAZARDOUS SPILLS, AND POLICE COMMUNICATIONS. THE HARRY DIAMOND LABORATORIES' TECHNICAL VOLUNTEER SERVICE (TVS) PROVIDES VOLUNTEERS TO ASSIST LOCAL GOVERNMENT AND SCIENCE AND TECHNOLOGY EDUCATIONAL INSTITUTIONS IN TWO ADJACENT COUNTIES. BECAUSE QUALITY SCIENCE AND TECHNOLOGY IS VITAL TO BOTH OUR NATION'S DEFENSE AND OUR INTERNATIONAL COMPETITIVENESS, THE ARMY ENCOURAGES SUCH INNOVATIVE PROGRAMS.

UNTIL THE PASSAGE OF PL 99-502, TECHNOLOGY TRANSFER ACTIVITY FOCUSED ON THE TRANSFER OF TECHNICAL INFORMATION WITH OFTEN UNDOCUMENTABLE PAYOFF. SUBSEQUENTLY, THE ARMY HAS COMPLETED 15 CRDAs AND TWO PLAs WITH PRIVATE COMPANIES, AND OTHER AGREEMENTS ARE IN NEGOTIATION.

IN SUMMARY, THE ARMY HAS MADE MANY SIGNIFICANT TECHNOLOGY CONTRIBUTIONS TO THE CIVILIAN ECONOMY SUCH AS LASER SURGERY, FREEZE-DRIED FOOD, ROTORCRAFT TECHNOLOGY, CONSTRUCTION ENGINEERING, AND PHOTOLITHOGRAPHY FOR MAKING INTEGRATED CIRCUITS. THE ARMY IS A LEADER IN TECHNOLOGY TRANSFER AS EVIDENCED BY:

O BEING AMONG THE FOUNDERS OF THE FEDERAL LABORATORY CONSORTIUM (FLC).

O HAVING A SUPPORTIVE REGULATION SINCE 1976.

O USING TECHNICAL VOLUNTEERS TO HELP IMPROVE SCIENCE AND TECHNOLOGY EDUCATION, AND

O RAPIDLY IMPLEMENTING COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT LEGISLATION.

WE APPRECIATE YOUR SUPPORT FOR THE DOMESTIC TECHNOLOGY TRANSFER PROGRAM WHICH WE BELIEVE IS MAKING A SIGNIFICANT CONTRIBUTION TO STRENGTHENING OUR NATIONAL ECONOMY AND SECURITY.

Mr. **Walgren**. Thank you, Mr. Singley. We appreciate that.

Mr. Rumpf.

Mr. **Rumpf**. Mr. Chairman, Thank you very much for being here, giving me this opportunity to be with you today.

My remarks will focus on trying to answer—hopefully set the stage for answering some of the GAO questions and some of the ones that you have addressed to earlier panels, sir. But let me begin by saying that we view technology as a force multiplier that enables our forces to act where superior quantities of other elements are the ones that we need to combat. We want to avoid technological surprises, and in that process, our laboratories are vital and key elements of our technology base within the Department of Navy.

We do, in fact, fully support and have implemented the Act of 1986. We recognize the creation of new products and the increase in standard of living and all the other attributes that come along with that transfer of technology into the private sector.

Some problems, however, that one needs to address are how to commercialize these technology products, getting them into the marketplace effectively and efficiently, rewarding our innovators with the carrot to counter the brain drain and the fiscal reliability, or I should say impediment, of current salaries in the Department, in civil service, as compared to private industry, which is certainly an area that has to be addressed and is one of the impetuses for our scientists and technicians to work in this particular program as a financial reward for their endeavors. But we must always remember that we need to protect vital technology from potential adversarial exploitation.

One of the areas of interest to you and the committee, as expressed by the GAO, was the status of our instruction on implementing this. In fact, each of our R&D centers has been doing this on their own hook at this point in time, on a case-by-case basis, with each CRDA coming forward to the Secretary for signature and approval until such time as the SecNav instruction, which is currently in his office, is signed. I anticipate that within a very short number of weeks from now, sir.

In fact, however—and I leave this for your staff and members to review—this videotape entitled, A Boost for American Initiation, is one that is available and has been used by our industries and our laboratories to state what the product lines are the industry can profit from from our laboratories and research establishments.

Forecasts for the future is picking up, as far as we're concerned. We had a large CRDA signed last two weeks and we've got two more in review right now. We expect four or five more to be negotiated within the next month or two, and I expect to see that the royalties will account for as much as $200,000 in fiscal year '90.

Is it working? My answer to you would be yes, sir. Several of our inventors got checks for over a thousand dollars in fiscal year '88. The smallest check was $165. It should be noted that the law, in the law 15 percent was raised to 20 percent by DOD instruction, and—as a minimum—and we can and are trying to exceed that. We see no problem with the way things are structured at this point in time, sir.

Is the technology community taking advantage and taking this item seriously? I would say definitely yes, from my poll of our people that our laboratories and research centers, because, in fact, they have—and we are making it part of their position description and performance goals, for those areas in which technology can be, without fear of national compromise, transferred to private industry.

Some examples already mentioned but should be highlighted again, artificial blood was an example of Navy technology transfer, both Navy and Army together, in that particular endeavor. Recently we're in the process—we are in the process of completing a CRDA between the Navy Research Laboratory and the Electric Power Research Institute for high voltage insulation breakdown. We also are in the process of a very large CRDA to be signed shortly between the Shipley Company and our Navy Research Laboratory on sub-micron lithography. Those are examples of areas that we're moving forward on.

Ninety percent of all of our budget on R&D has its commercial rights spoken for, so by industry and the prime contractor and subcontractor role. Hence, the remaining 10 percent is what we're focusing on for this endeavor. We have, in fact, 17 royalty-bearing licenses in enforcement right now, bringing in $13,000 in calendar year '88. In '89 we have $53,000 so far, and we expect over $100,000 by year end. I mentioned to you that we expect in fiscal year '90 over $200,000 in royalty.

In fact, sir, if I may summarize, some of the issues that we see for help from your committee and consideration among ourselves, the issue of FOIA, which is a problem that we raised with your staff yesterday to examine, and you already have as a model law Public Law 100-680, 1988, the Steel and Aluminum Energy Conservation and Technology Competitiveness Act. This FOIA exemption is the possibility to help encourage industry play with us more because they're fearful of entering a CRDA and then having that openly exposed and their competitive advantage lost.

The issue of software copyright and also previously mentioned by panel two is of concern to us and should be examined in greater depth as well. And thirdly, using as a sort of a government-wide, industry needs collector, a full utilization of whatever facility is available to us now, and perhaps Dr. Schmid's organization is the right place to do that.

Therefore, Mr. Chairman, we believe that we have and will continue to fully implement the law and, with careful groundwork laying the process to do that legally and correctly, within the Department, we believe that we can transfer technology without exposing ourselves to technology drain in some critical areas such as antisubmarine warfare and other areas.

[The prepared statement of Mr. Rumpf follows:]

RICHARD L. RUMPF

Richard L. Rumpf, a long time Colorado resident, is the Principal Deputy Assistant Secretary of the Navy for Research, Engineering and Systems. In this capacity he is responsible for the planning and directing of research, development, engineering, testing and evaluation of future weapons, sensors, ships, aircraft, unmanned vehicles and space vehicles for the United States Navy and Marine Corps; and for managing a budget of over nine billion dollars.

Graduating from the University of Colorado with a Bachelor of Science degree in Aeronautical Engineering, he spent a year at, and graduated from, the Von Karman Institute for Fluid Dynamics in Belgium, then returned to the University of Colorado to earn a Master of Science degree in Aerospace Engineering. After working in internal aerodynamics and propulsion as a design and test engineer at the Johns Hopkins University/Applied Physics Laboratory from 1968 to 1978, he joined the Office of the Assistant Secretary of the Navy in March 1978 as the Staff Engineer for Missile Systems. In November 1981 he became the Acting Director for Air Programs, and served as the Director for Air Programs in the Office of the Assistant Secretary of the Navy from March 1982 to June 1985, at which time he assumed his current position. From April 1987 to December 1987 he also served as the Acting Assistant Secretary of the Navy for Research, Engineering and Systems.

Active across a broad spectrum of issues, he has chaired the Blue Ribbon Oversight Committee of the All-weather Attack Aircraft Study, which led to development of the A-12 aircraft, and the HARM Alternative Study, he was the principal Navy member of the Joint Requirements Management Board Studies on Cruise Missiles and Remotely Piloted Vehicles and the AMRAAM Cost/Alternative Study. He chaired the first Anti-Submarine Warfare (ASW) Master Plan Blue Ribbon Review Panel, and most recently, has been a new figure in the establishment of a Joint RPV Program Office and Master Plan. He is a key figure in the Navy's thrust in international cooperative development strategy having initiated several Memoranda of Understanding with U.S. allies. He serves as principal Navy advisor to several Defense Science Board committees.

In 1987 he received from President Reagan the Distinguished Executive award in the Senior Executive Service. He also received the Navy's Distinguished Public Service Award. In 1986 he received the President's Meritorious Executive award in the Senior Executive Service.

Married to the former Lenore Myers, they reside in Arlington, Virginia.

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE NAVY

STATEMENT ON DOMESTIC TECHNOLOGY TRANSFER

BY

MR. RICHARD L. RUMPF
ACTING ASSISTANT SECRETARY OF THE NAVY
(RESEARCH, ENGINEERING AND SYSTEMS)

TO THE

SUBCOMMITTEE ON SCIENCE, RESEARCH AND TECHNOLOGY
OF THE
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
101ST CONGRESS, FIRST SESSION

JUNE 1, 1989

INTRODUCTION

Good Morning. I am pleased to appear before you to describe the Navy Domestic Technology Transfer Program. I'll describe the process the Navy is setting up for this effort and give you a status report on our progress.

It is important to keep in mind the context in which the Navy conducts research and development (R&D). The products of such R&D are systems intended to enable the U. S. Navy to both defeat a numerically superior force in a combat environment and to carry out its peace time mission of presence. It is also intended to keep us abreast of advances that potential adversaries make so that we can counter such advances in our planning and strategy development.

Experience has shown that, even though such research and development was not intended to be applicable to civilian products, there are considerable benefits and applicability of the developed technologies to private sector goods. Such applications can and have produced products that either provide new capabilities or old capabilities less expensively. Such products obviously help the country by raising the standard of living and by providing products for international trade. The Navy has long recognized such benefits. Navy laboratories were among the founding fathers of the Federal Laboratory Consortium (FLC), one of the principal players in domestic technology transfer activities. The Navy has long had an active program for licensing its patents and technology. We believe in the benefits of domestic technology transfer.

The current Department of the Navy (DON) program is taking this existing involvement and modifying it so that it is consistent with the new laws. We are working to commercialize Navy technologies while at the same time attempting to avoid making the Navy vulnerable to having these technologies exploited by our potential adversaries. The problem, therefore, is to move appropriate DON technology efficiently and effectively into the market place, and at the same time to more or less maximize the licensing fees that would come to the DON activities responsible for the technology development.

I'll describe the system we believe does all of this, then give you the current status, and then finally outline what we think should be done on a national level to expedite the process.

THE NAVY DOMESTIC TECHNOLOGY TRANSFER SYSTEM

Under current government policy the contractor has the right of first refusal on the commercial application of technology developed under a contract. Thus about 90% of all Navy R&D programs have the resultant commercial rights "spoken for." Of course in these cases the Government has a royalty-free use privilege. In the current situation, the technology that the Navy has available for commercialization is restricted to that developed in its own laboratories or what a contractor chooses not to patent.

There are two main aspects to the commercialization of Navy *technology developed in-house: (1) the licensing of* technology developed solely in the Navy Laboratories or contractor-developed technology patented by the Navy; (2) the cooperative development of new technology through Cooperative Research and Development Agreements (CRDAs). In the case of licensing Navy-developed or Navy-owned/contractor-developed technology, as I said before, the Navy has long had an active program. The latest Navy Instruction on the subject reaffirms the designation of the Chief of Naval Research (CNR) as the responsible agent for patent licensing, but also calls on all Navy R&D laboratories to actively market the products of their Navy employee efforts. In the case of CRDAs, a two-tiered system is envisioned. Those research and development activities that have demonstrated the ability to develop and negotiate CRDAs would be delegated the authority to enter into such agreements on their own. The agreement would then be forwarded to the CNR for post-signature review to assure that the activity should continue to retain the delegated authority. Those organizations that have not demonstrated such abilities (generally those less active in technology transfer) would forward the signature-ready agreement to the CNR for review approval and delegation of authority to sign. The review shall not take longer than the 30-day period provided for in the law. If the agreement requires rework, only the reworked sections will be re-reviewed upon resubmittal. The review will look at three areas of potential concern; compliance with the law, compliance with Navy policy, and appropriateness of business interactions. Only legal and/or policy concerns will be grounds for nonapproval; the business aspect concerns will be furnished back to the originating organization for whatever treatment it believes is appropriate. It should be emphasized that the Navy is trying to provide as much latitude as possible in the development of the CRDAs. The principal headquarters concerns are compliance with the law and Navy policy and that the Navy is adequately protected from a liability standpoint.

In passing, I'd like to mention that we believe that the technology transfer program will have at least one beneficial tangential aspect. It should enable the Navy to recruit and retain the innovative technical people that it needs to make its R&D programs successful. The sharing of royalties is not usually a privilege of industry employees.

The operation of the Navy system will be in the hands of the individual Laboratories' Offices of Research and Technology Applications (ORTA), the DON patent attorneys and the Office of the Chief of Naval Research. Virtually all of the major Navy R&D laboratories have had technology transfer activities since at least the early seventies. These activities have been consolidated and identified as the organization ORTA. Assignment of ORTA responsibilities at the smaller activities is underway.

The patent attorney organization and the OCNR policy team are fully functional. The Navy team is in place and operational.

CURRENT STATUS

Any current status assessment must start with the fact that about 90% of Navy R&D program has the commercial rights for developed technology assigned to the contractors. This practice has long been the major way that Navy paid-for technology has gotten into the civil market place. The Navy has, for a number of years, also had a program for the licensing of technology developed in-house. For example, the Navy has 17 royalty-bearing licenses currently in force. The royalties paid about $13,000 in 1988, of which almost half ($5,800) went directly to the inventors. In 1989 we expect to see the royalties jump to over $100,000. There are also over one hundred non-exclusive non-royalty bearing licenses in place. While these last provide no money to the Navy, they do transfer technology.

The Navy is also moving in the CRDA area. One has been signed, one is about to be signed and several more are in negotiation. The Navy is also planning, on a pilot program basis, a technology TransFair for August of 1989 at Kansas City to promote the transfer of Navy technology to industry. It will present what we feel are the more commercially oriented available technology developments to industry.

It should also be noted that the Navy puts out a technology transfer "Fact Sheet." This monthly publication goes to a mailing list of about 8,000 and provides data on laboratory developed technology available to the commercial community.

POTENTIAL SYSTEM IMPROVEMENTS

There are some items that would make the system work a little better, however. One desirable item would be the ability to copyright software. Since most government developed software needs considerable further development to turn it into a viable commercial product, most companies want to protect their investment through the acquisition of such copyrights. The lack of protection inhibits government developed software from further commercial use. Some examination of this area is warranted to see if such a non-copyright policy continues to be in the government's best interests.

A second item that requires sensitive handling and may inhibit some contractors from CRDA participation is the applicability of the Freedom of Information Act (FOIA) to government-industry developed data. The thought that the developed data might be made available to a competitor through an FOIA request has been cited as being a reason for not entering into such an agreement. The Navy currently works with potential contractors to attempt to resolve their concerns within the existing law.

SUMMARY

In summary, I want to emphasize the following: In about 90% of the Navy R&D programs the intellectual property rights have been allocated to the contractors through the contracting process. The Navy has a system that is just coming on-line to accomodate the remaining 10% and we are confident that our system will protect the Navy's interest while at the same time accomplishing both the spirit and letter of the 1986 Technology Transfer Act.

Mr. WALGREN. Thank you for that testimony, Mr. Rumpf.

General Douglass.

General DOUGLASS. Good morning, Mr. Chairman. This is my first opportunity to appear as a witness on the Hill. I've been a supporting witness many, many times, and so I just wanted to start my testimony by thanking you for inviting me and telling you that we in the Air Force have a great deal of respect for you and your committee, sir, and the high standards that you use for this subcommittee.

Sir, the first point that the Air Force wants to make is we have a very high incentive to see a strong national technology base. We participate very heavily in that endeavor. As a matter of fact, in 1988, I was the Air Force representative on a Defense Science Board summer study on the defense technological and industrial base and I would commend that study to you, sir, if you haven't had a chance to see it yet. It draws some of the very strong linkages between our military-industrial base and our commercial industrial base and technology base in this country. We understand that in the Air Force and we're very supportive of the efforts and commend you for what you're doing, sir.

As you know, the Air Force has a long history, and the Army Air Corps before it, of working with civil aviation, to move forward commercial technology in various ways. In the old days we were very much involved in things like moving air mail in the very beginning and all kinds of altitude and speed records and things of that nature. And certainly during World War I and World War II many of the military technologies found their way into commercial aviation.

Some of my colleagues mentioned some of the more recent examples. The Air Force has been very active, of course, in the development of lasers, and just to add to what they said, their ring laser gyros in commercial aircraft today have made inertial navigation accuracies far beyond that what we thought was previously attainable, and of course, the global positioning system, which the Air Force is sponsoring, will make—that Dr. Millburn mentioned—will make global navigation much, much more accurate for the commercial sector as well as the military sector.

I might also add I was personally involved a few years ago in the development of the air-launched and sea-launched Cruise missiles with my friend, Mr. Rumpf here. You might be interested to know that the developer of the engine in that missile was a fellow by the name of Sam Williams, who developed that engine jointly with the Air Force and the Navy. And he won the Collier Trophy in I think about 1986 for that work. That work in small turbines is widely distributed to the commercial industry and it's making a fairly large impact there. So we're a solid supporter, sir, of the technology transfer initiatives.

The Air Force has been, we think, reasonably successful in providing and disseminating information on federally-owned or originated products, and processes and services having potential application to state and local governments, and commercial industry.

Specifically, we're fulfilling our responsibilities under the Act by the establishment of Offices of Research and Technology Applications, by the establishment of a Domestic Technology Transfer functional office, by the finalization of Cooperative Research and Development Agreements—we have 24 of the 172 that GAO mentioned. That's about 14 percent of the total, and we also see that increasing and growing and we're putting emphasis on it.

We funded our share of the Federal Laboratory Consortium and we're developing handbooks for our people to use to try to expedite the intent of the Act.

Now, your staff was concerned about the royalties. The Air Force has realized about $75,000 to date in royalties. We agree with some of the comments that have been made before, that if the royalties are small, they ought to be given out in one single payment. We have promulgated procedures to make that happen.

In summary, the Air Force has made considerable progress in establishing the domestic technology transfer program. I am confident that as we become more familiar and comfortable with the legislation, our process will accelerate. We realize that to succeed in technology transfer and commercialization as defined in the Act, each laboratory must be allowed the flexibility to develop relationships with organizations that have a mutual interest in technology development and commercialization.

We are well embarked on our program. It needs a little time to grow. I have looked at what the GAO said. We agree that the implementation is spotty, and I make a personal commitment to you, sir, to go back and work that—when we get that GAO report in its final form, I'll seriously address it and do what I can to fill any holes that exist.

We've put our instructions out to the field, and so we think that our folks know how to do what's called for in the Act. We support it, sir.

[The prepared statement of General Douglass follows:]

Statement of Brigadier General John Douglass
Director of Science and Technology
Assistant Secretary of the Air Force for Acquisition

Before the
Subcommittee on Science, Research, and Technology
Committee on Science, Space, and Technology
United States House of Representatives

on

Air Force Domestic Technology Transfer

June 1, 1989

Good morning, Mr. Chairman. The Air Force and I thank you for this opportunity to appear before your committee in order to describe the Air Force domestic technology transfer program.

As you know, Mr. Chairman, Air Force research, development, test, and evaluation (RDT&E) is dedicated to national security-related research and development (R&D) efforts. We recognize in addition that a number of R&D programs we sponsor have the potential of being of value to the commercial sector of the United States economy.

We are proud of our record of seeing the R&D efforts that we sponsor find their way successfully into the commercial marketplace. A very notable example is the use of laser technology in the fields of medicine and production processes.

On the other side of the coin, however, since our research is related to national security, there some R&D efforts must be controlled to prevent their exploitation by potential adversaries. With increasing transfer of Air Force technology comes a corresponding increase in the risk that an adversary will be able to capitalize on the availability of such defense-related technology. Adversaries may be able to "leapfrog" our R&D efforts and make gains in warfighting capability in a relatively fast, low cost, and low risk fashion. However, while this is a complicating factor, it is not a "show stopper."

We believe that the most opportune time within the R&D cycle to maximize domestic technology transfer is in the basic research and exploratory phases of the overall RDT&E program. This is where we are thus focussing our attention.

The Air Force basic and exploratory development programs are conducted primarily by universities and commercial firms. We believe this relationship significantly contributes to the domestic technology transfer program. This is particularly true for the larger firms that have both national security and commercial business bases. In this case, it is in the firms' best interests to get clearance from the Air Force for specific technologies that can be commercialized without adversely affecting national security. Larger firms also have, for the most part, local representatives at the different R&D locations. These representatives can identify R&D efforts that may have commercial potential. Such large firms also usually have ready access to available technical data bases such as those maintained by the National Technical Information Service (NTIS).

In contrast to the case of the larger firms, however, smaller, less established firms typically do not have the laboratory representatives or easy access to available data bases such as those of NTIS. Therefore, it is in this segment of American industry where domestic technology transfer activities can have a relatively high payoff for the Air Force resources invested.

The "bottom line" is that the transfusion of new and emerging military technologies into commercialized technology and products can be a significant factor in keeping the United States apace with other nations in the ever increasing competitiveness of the international market place.

Because of this, the Air Force requires all scientific and engineering activities to initiate and undertake technology transfer endeavors, including entry into appropriate cooperative research and development agreements (CRDAs), establishment and use of Offices of Research and Technology Applications (ORTAs), and negotiation of patent licenses or other types of licenses as determined appropriate to enhance the transfer of unclassified technology from the Air Force to society and the marketplace.

The Air Force strongly supports the technology transfer initiatives set forth in the Stevenson-Wydler Technology Innovation Act of 1980, the Federal Technology Transfer Act of 1986, and Executive Order 12591, "Facilitating Access to Science and Technology." The Air Force has been successful in providing and disseminating information on federally-owned or originated products, processes, and services having potential application to state and local governments, and commercial industry.

By allowing for explicit recognition of developments stemming from individual labs or staff members, technology transfer programs also can be a positive influence in recruiting and retaining qualified science and engineering personnel.

In addition, the Air Force regards university research as a viable mechanism for technology transfer by using university research personnel and capabilities in Air Force-related research.

More specifically, the Air Force is fulfilling its responsibilities for domestic technology transfer in a variety of ways, including:

- Establishment of Offices of Research and Technology Applications,
- Establishment of a Domestic Technology Transfer functional office,
- Finalization of Cooperative Research and Development Agreements,
- Funding of the Federal Laboratory Consortium, and
- Development of Technology Transfer Handbooks.

I would now like to give you some details on the Air Force's use of each of these technology transfer approaches.

The Air Force is performing its oversight function of PL 99-502 via the Offices of Research and Technology Applications (ORTA), established at each laboratory as specified in the legislation. The functions of the ORTA include preparing technical assessments for selected research and development projects that may have commercial potential, disseminating information on technology that has potential commercial application to the private sector and to state and local governments, and assisting government and business organizations in the transfer of technology.

To provide assistance to United States industry, the Air Force has established a domestic technology transfer functional office within the Office of the Assistant Secretary of the Air Force for Acquisition. This office provides assistance to laboratories as required to ensure that efforts to transfer technology are responsive and consistent with Statute and Executive Order, makes reports to Congress, promulgates regulations and operating procedures, transfers funds to the National Institute for Standards and Technology, supports the Federal Laboratory Consortium for Technology Transfer, and develops a cash awards program and a plan for its implementation.

Authority to enter into Cooperative Research and Development Agreements (CRDAs) has been delegated to the laboratories through Headquarters Air Force Systems Command. Twenty-four Air Force CRDAs have been or are currently being negotiated; this is more than half of the CRDA's in place or pending within DOD. These CRDAs have been negotiated with state and local governments, academia, and private industry. We anticipate that the number of CRDAs will grow as our labs become more familiar with the legislation.

Air Force funds were transferred to the National Institute of Standards and Technology (NIST) in 1987 and 1988 to support the Federal Laboratory Consortium (FLC) for Technology Transfer. The Air Force will continue to actively support and participate in the FLC by transferring 0.008 percent of its laboratory budget to carry out the activities of the Consortium.

The Air Force's Human System's Division (HSD) has recently developed a Technology Transfer Handbook, containing an overview of the technology transfer process, the relevant statutes and executive orders, and additional information on CRDAs, licenses and patents, and the NIST and FLC. We are investigating development of an Air Force wide Technology Transfer Handbook for Air Force-wide use that would serve to educate scientific and engineering personnel on the opportunities, responsibilities, and potential rewards for furthering technology transfer and about the benefits of patent licensing. This Air Force handbook will provide a firm foundation for developing an Air Force universal handbook. Such a comprehensive handbook will also help impart a consistency to the Air Force technology transfer efforts.

At this time, all licensing of invention disclosures for patent application has been "in-house", with the assistance of Air Force patent attorneys. We are looking into the practicality of using broker services to handle license agreements, to seek out laboratory technologies with commercial potential, and assist in-house transfer.

To date, the Air Force has realized about $75,000 from royalty income. Based on DOD guidance, the inventor receives 20% of the royalty on his or her right in the invention; joint inventors will share the 20% equally. If the annual income is less than $1,000 times the number of inventors, the inventors will receive the entire amount divided equally. The balance of the royalties go to the activity where the invention occurred. In this regard, the laboratory commander/director may utilize up to 20% of these funds to reward other Federal employees who develop valuable inventions which cannot be commercialized for national security reasons or because their utility is significant only within the context of the DOD mission.

In summary, the Air Force has made considerable progress in establishing the Domestic Technology Transfer Program, and I am confident that as we become more familiar and comfortable with the legislation, our progress will accelerate. We realize that to succeed in technology transfer and commercialization as defined in the Act, each laboratory must be allowed the flexibility to develop relationships with organizations that have a mutual interest in technology development and commercialization.

The Air Force is well embarked on establishing a strong technology transfer program. We are committed to continued efforts in this area, to the resolution of any staffing or funding shortfalls, and will provide the necessary impetus to achieve an even stronger program.

Mr. **Walgren**. Okay. Well, thank you very much, General Douglass. And I want to express my appreciation to all of you on behalf of the subcommittee for your presentations. We'll develop some of your testimony with some written submissions we might make to you.

I do want to commend you for the good work that you do, and I know that all of us in the Congress, when we go to our districts, see the result of the technology development work that the services, all of them, have done. You have some very good programs in place and you should know that that's appreciated.

We also, of course, look to you for the maximum effect of this kind of legislation because you are at such a central position in it. So we want to encourage you and urge you and bring a good public record to bear on what kinds of things are being done on the military side.

So, with that, let me thank you very much. Those bells have—are indicating that the House is assembling to attend the services for former Senator Pepper, who was such an institution and contributed so much over so many years to the democracy that we have. So there is a very important recognition of that life that we all should stop and think about a little bit.

So thank you very much for coming. I appreciate your cooperating with us to end this in a timely manner. Thank you.

[Whereupon, at 11:45 a.m., the subcommittee adjourned.]

APPENDIX

QUESTION: Based on the 1988 National Research Council report on Photonics: Maintaining Competitiveness in the Information Era, as well as on the views of many scientific experts throughout the world, and in view of major research and manufacturing programs recently initiated by Japan and Europe in the area of photonics, specifically opto-electronics, what is the DOD specifically doing to bring Photonics to the point of weapon system insertion by the mid-to-late-nineties, thereby maintaining the current U.S. leadership in this critical technology? Is the current level of DOD resources adequate to ensure our continued leadership?

QUESTION: Is Photonics being considered as a "leapfrog" technology, with emphasis on manufacturing technology as well as on materials/information processing technologies, in order to preclude past experiences (e.g., microelectronics) whereby the U.S. led in developing the technology, only to have Japan assume world leadership through its manufacturing expertise? As a counter to a major Photonics program recently announced by Japan's MITI (Ministry of International Trade and Industry), is DARPA planning any major program in this area? If not, should one be initiated?

PHOTONICS TECHNOLOGY

Question: What is the DoD specifically doing to bring Photonics to the point of weapon system insertion by the nineties? Is the current level of DOD resources adequate to ensure our continued leadership?

Answer: We can only respond to the Army's role in this critical technology. In its recently developed Technology Base Master Plan (ATBMP), the Army has identified Photonics as one of the thirteen key emerging technologies. This Plan, which has been approved by the Secretary of the Army and the Army Chief of Staff, allocates 25% of the entire technology base resources to meet specific technical objectives within these thirteen key emerging technologies. The time frame for demonstrating these objectives for fielded and future weapon systems is early-to-mid nineties.

Currently the Army funds Photonics research and development programs in optical processing of information, optical image processing, optical computing, optical acoustics, and optical signal processing. The Army funding for this fiscal year for these activities is approximately $25 million. Funding for future Photonics programs within the Army is projected to increase significantly as outlined in the ATBMP. Current and future funding levels are considered adequate for meeting the Army's mission of inserting this technology into Army weapon systems such as the communication modules and automatic target recognition for land and air-based vehicles. The Army research and development efforts in Photonics are conducted in the Electronic Technology Devices Laboratory, the Harry Diamond Laboratory, the Communication and Electronic Command's Center for Night Vision and Electro-Optics, the Missile Command, and other Army research and development organizations.

Question: Is DARPA planning any major program in this area? If not, should one be initiated?

Answer: Although DARPA should provide the information requested in this inquiry, the Army is aware of a recent DARPA-initiated Broad Agency Announcement which seeks to accelerate the development of Photonics technology. However, the Army cannot provide information relevant to the funding level for this effort or for other DARPA programs in Photonics. For its part, the Army is certainly cognizant of Japan's Ministry of International Trade (MITI) comprehensive initiative in Photonics technology.

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June 9, 1989

Mr. George T. Singley, III, Director
Office of the Asst. Secretary of the Army
(Research, Development and Acquisition)
Department of the Defense
Washington, D.C. 20301-1155

Dear Mr. Singley:

Thank you for testifying last Thursday at the Subcommittee's hearing on the Federal Technology Transfer Act. We appreciated learning from you the progress that the Army has made in implementing the Act in the two and one-half years since passage.

Because of the time constraints imposed by the services for Hon. Claude Pepper, we were not able to ask the DOD panel questions. Attached is a list of questions to which we would appreciate your early reply.

Again, thank you for your testimony.

Sincerely,

Doug Walgren

DOUG WALGREN
Chairman, Subcommittee on Science,
Research and Technology

DW:Wcw
Enclosure

Questions for Mr. Singley

1. At the present time, what review of laboratory-negotiated cooperative research and development agreements and licensing agreements is required at the Army headquarters level?

   Is the requirement that adverse action on any such negotiations be handled within 30 days from date of receipt by your department being complied with?

2. What regulations and instructions still must be promulgated by your service to fully implement the cooperative R&D authority? What is the timetable?

3. In the next year or so, what level of growth do you expect in the number of cooperative R&D agreements negotiated by Department of the Army laboratories?

4. With regard to Section 11(a)(3), how has your Service insured that technology transfer is being considered positively in laboratory job descriptions, employee promotion policies and evaluation of job performance of scientists and engineers in your laboratories?

5. Have your laboratories established Offices of Research and Technology Applications (ORTA's) and staffed them as required by the law?

6. Are there any legislative changes to the law which you believe would be desirable?

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON DC 20310-0103

2 6 JUN 1989

Honorable Doug Walgren
U. S. House of Representatives
Washington, D. C. 20515

Dear Congressman Walgren:

This is in response to your June 9, 1989 letter (Attachment 1) concerning the Subcommittee's hearing on the Federal Technology Transfer Act. Answers to your questions are as follows:

1. Following execution of the agreement by the Laboratory Commander or Director, the agreements are reviewed by the Army Domestic Technology Transfer Program Manager on behalf of the Office of the Assistant Secretary of the Army for Research, Development and Acquisition in accordance with the guidelines provided as Attachment 2. The 30-day limit on handling adverse actions is being met in compliance with the legislation.

2. The delegation of authority to the Commanders or Directors of Army Laboratories and Research, Development and Engineering Centers (RDECs) to enter into Cooperative Research and Development Agreements has been formally completed, and interim guidelines on processing the agreements have been issued (Attachment 2). Revision of the Army Regulation (AR 70-57) to include the detailed guidance on establishing cooperative agreements is scheduled for completion by June 1990. No further action on the delegation of authority is needed.

3. The Army currently has 17 cooperative agreements in place, and this number is forecasted to be 100 or more by the end of FY90.

4. Information regarding legal requirements, including those of Section 11(a)(3), to the Commanders or Directors of all Army Laboratories and RDECs has been distributed; however, implementation has been uneven and incomplete. A more uniform and vigorous implementation of this Section of the law will result from a current intensive review of the Domestic Technology Transfer Program by this office.

5. All Army Laboratories have established an Office of Research and Technology Applications, and 80 percent of these organizations are staffed with at least one full-time equivalent in conformance with the law. This entire issue will be resolved as part of the current program review.

6. Two actions by the Congress to enhance the technology transfer effort are recommended:

a. Congress should consider providing copyright protection for computer software and courseware created by Federal employees and provide for royalties in licensing agreements as with government patents.

b. Clear protection from unwarranted disclosure under an FOI Act request should be given to the information generated by the Federal collaborators in accordance with a statement of work under a CRDA.

We would be pleased to provide any additional information that you might desire. Thank you for the opportunity to explain the Army's program on Domestic Technology Transfer.

Sincerely,

G. T. S

George T. Singley III
Director
Research and Technology

Attachments

SARDA-TR
REVISED INTERIM GUIDELINES FOR PREPARATION AND REVIEW OF COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS (CRDAs) AND PATENT LICENSE AGREEMENTS (PLAs)

b. At the end of paragraph 11.2 of the model, add the words "under the provision of the Federal Tort Claims Act."

c. If the other party (ABX Company, Inc.) insists, the following provision may be inserted at an appropriate location (such as paragraph 13.3 of the Model Agreement):

13.3 Ratification. In the event that the Assistant Secretary of the Army (Research Development and Acquisition) exercises the authority reserved by paragraph 8.1.3, ABX Company, Inc. shall have 30 days from notification of the required modification to ratify the modifications or terminate the Agreement.

3 - The final negotiated version of the CRDA or PLA as signed by the laboratory commanders/directors will be provided with a cover sheet having the following information:

a. Name of company(ies) with which agreement was made

b. Name, address and telephone number of company POC

c. Name and phone number of laboratory POC

d. Name and phone number of laboratory legal counsel

e. Summary of agreement stating specifically the contributions of each side

f. Principal differences between the agreement and the Department of Commerce Model

4 - The original and 2 copies of the completed CRDA or PLA (with cover sheets) will be prepared by the laboratory. The original will be sent to the Domestic Technology Transfer Program Manager, US Army Harry Diamond Laboratories, ATTN: SLCHD-TT (Mr. Clifford Lanham), 2800 Powder Mill Road, Adelphi, MD 20783-1197 where its receipt will be logged on behalf of the Office of the Assistant Secretary, the review will be coordinated, and records of each original CRDA and PLA will be maintained for the Army. At the same time one copy will be sent to the Office of the Assistant Secretary of the Army for Research, Development, and Acquisition, ATTN: SARD-TR (Dr. H. El-Bisi), Room [redacted] 3E510, The Pentagon, Washington, DC 20310-0103 and the other copy to the Army Counsel for Intellectual Property, Office of the Judge Advocate General, ATTN: JALS-PC (Mr. A. Lane), Room 332A Nassis Building, 5611 Columbia Pike, Falls Church, VA 22041-5013 for review.

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310

SARD-TR

8 July 1988

REVISED INTERIM GUIDELINES FOR PREPARATION AND REVIEW OF COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS (CRDAs) AND PATENT LICENSE AGREEMENTS (PLAs)

In accordance with Sections 11(a) (1) and (2) of the Federal Technology Transfer Act of 1986, Public Law 99-502, amending the Stevenson-Wydler Technology Innovation Act of 1980, Public Law 96-480 and Section 1(b)(1) of Executive Order 12591, dated April 10, 1987, the authority:

(1) to enter into cooperative research and development agreements and

(2) to license, assign or waive rights to intellectual property developed by the laboratories either under such cooperative research and development agreements or from within individual laboratories

has been delegated to the Commanders/Directors of Army laboratories. The authority to disapprove or require modification to the arrangements identified in (1) and (2) above is retained by the Assistant Secretary of the Army (Research, Development and Acquisition).

To allow the timely development of Cooperative R&D Agreements (CRDAs) and Patent License Agreements (PLAs) to advance the purposes of the Federal Technology Transfer Act of 1986 in a manner which best serves the US public interest, the following updated version of the interim guidelines are provided until the revision of AR 70-57 and the issuance of other needed regulations can be accomplished.

1 - CRDAs and PLAs will be developed by laboratory commanders/directors with advice from local intellectual property counsel.

2 - The Department of Commerce Model Cooperative Research and Development Agreement, draft dated 4 Nov 87, may be used as a model but the following modifications are required:

a. The following must be substituted for paragraph 8.1.3 in the model:

8.1.3 Authority. All prior reviews and approvals required by regulations or law have been obtained by XYZ prior to the execution of this Agreement. The XYZ official executing this agreement has the requisite authority to do so. Notwithstanding the delegation of authority to execute this agreement to the individual designated, the Secretary of the Army has reserved to the Assistant Secretary of the Army (Research, Development and Acquisition) the opportunity provided by 15 United States Code section 3710a(c)(5)(A), to disapprove or require the modification of this Agreement within 30 days of the date it is presented to him or her by XYZ.

SARD-TR
REVISED INTERIM GUIDELINES FOR PREPRATION AND REVIEW OF COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS (CRDAs) AND PATENT LICENSE AGREEMENTS (PLAs)

5 - The Program Manager, after assuring receipt of copies by each reviewer will acknowledge the receipt of each agreement by a letter to the laboratory commander/director stating a control number and log date which officially begins the 30 day period during which the agreement may be disapproved or modification required.

6 - The Intellectual Property Counsel will provide legal review and comments to the Program Manager within 10 days of the log date.

7 - The Program Manager will provide a review of the CRDA or PLA for Army policy issues along with the report of legal findings from the Intellectual Property Counsel and, based on all recommendations, will provide a draft letter for SARDA to notify the laboratory commander/director of the approval or disapproval of the agreement or of any modifications required.

Dr. Hamed M. El-Bisi
Deputy Director for Research
and Technology

THE ASSISTANT SECRETARY OF THE NAVY
(RESEARCH, ENGINEERING AND SYSTEMS)
WASHINGTON, D.C. 20350-1000

Jim Turner

JUL 06 1989

The Honorable Doug Walgren
Chairman, Subcommittee on Science,
Research and Technology
Suite 2321
Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

I was very pleased to discuss the Navy's efforts toward implementation of the Federal Technology Transfer Act at the Subcommittee's hearing. We believe the Navy is positively responsive to the spirit of the Act.

Enclosed are my responses to the questions posed with your letter of June 9. Thank you for this additional opportunity to present the Navy perspective.

Sincerely,

Richard L Rumpf

RICHARD L. RUMPF
Acting

Enclosure

QUESTIONS AND ANSWERS

1. To date, has authority been delegated to your laboratory directors to enter into cooperative research and development agreements and to negotiate licensing agreements pursuant to Public Law 96-480 as amended and Executive Order 12791?

RESPONSE: Authority to enter into a specific cooperative research and development (CRDA) has been delegated to the Commanding Officer of the Naval Research Laboratory. As more CRDA's are negotiated by Navy laboratories and approved, the commanding officers will be given authority to sign. The laboratories for some time have had the authority to negotiate licensing agreements, subject to approval of the Office of the Chief of Naval Research.

At the present time, what review is required at the Navy headquarters level?

RESPONSE: Each CRDA is reviewed for compliance with the law, for compliance with Department of the Navy policy, and for business aspects.

Is the requirement that adverse action on any such negotiations be handled within 30 days from date of receipt by your department being complied with?

RESPONSE: Yes. It is a requirement that the concerned laboratory be notified of the disposition of the CRDA within 30 days.

2. What regulations and instructions still must be promulgated by your service to fully implement the cooperative R&D agreements negotiated by Department of the Navy laboratories?

RESPONSE: A Secretary of the Navy (SECNAV) instruction and an Office of the Chief of Naval Research (OCNR) instruction are currently planned to create the paper trail for cooperative R&D agreement authority. It should be noted that the system is in place and operating. The only thing that will change when these are written is that the Chief of Naval Research will no longer request authority to allow the laboratory commanding officer to sign a CRDA. The SECNAV instruction is being coordinated in the Navy Secretariat and should be approved and issued soon. The implementing OCNR instruction is written and is in informal coordination. It will be formally coordinated when the SECNAV instruction is signed.

3. In the next year or so, what level of growth do you expect in the number of cooperative R&D agreements negotiated by the Department of the Navy laboratories?

RESPONSE: I expect that there will be 5 to 10 technology development CRDA's and several more that enable other cooperative efforts such as testing industry developed equipment on government ranges. It may be important to note here that the majority of Navy-funded research and development is through university, profit and non-profit organizations' contracts that allow those organizations to patent the results. Therefore, although the Navy receives royalty-free license for use, the technology is already available for exploitation by non-government activities. A lesser percentage of Navy research and development funds goes to the in-house laboratories. The Navy cooperative R&D agreements can use only that in-house effort.

4. With regard to Section 11(a) (3), how has your Service insured that technology transfer is being considered positively in laboratory job descriptions, employee promotion policies and evaluation of job performance of scientists and engineers in your laboratories.

RESPONSE: The OCNR instruction will instruct all R&D organizations to include technology transfer elements in appropriate job descriptions, employee promotion policies, and job performance evaluation criteria.

5. Have your laboratories established Office of Research and Technology Applications (ORTA's) and staffed them as required by the law?

RESPONSE: At this time all of the major laboratories (14) have full-time equivalent staffed ORTA's. The smaller laboratories are establishing ORTA's and designating focal points where they do not already have them.

6. Are there any legislative changes to the law which you believe would be desirable?

RESPONSE: The ability to copyright software would make it more attractive for commercial development. The present lack of protection inhibits companies from the extensive further development required to turn government-development software into a viable commercial product. Whether the non-copyright policy continues to be in the Government's best interest should be examined.

Potential applicability of the Freedom of Information Act (FOIA) where government-company developed data could be the subject of a FOIA request by a competitor inhibits some companies from entering into CRDA's. Specific FOIA exemption might be considered.

Coordination, consolidation, and organization of industrial needs data by a central organzation would be more efficient than individual agency collection. Tasking to a central organization, such as the Federal Laboratory Consortium (FLC) is suggested.

[illegible]

[illegible]

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June 9, 1989

Dr. George P. Millburn
Deputy Under Secretary of Defense
(Research & Advanced Technology)
Department of Defense
Washington, D.C. 20301-1155

Dear Dr. Millburn:

Thank you for testifying last Thursday at the Subcommittee's hearing on the Federal Technology Transfer Act. We appreciated learning from you the progress that the Defense Department has made in implementing the Act in the two and one-half years since its passage.

In your testimony you mention that the Department of Defense is developing a data base on areas of expertise within the DOD laboratories. When do you expect this data base to be fully operational? Who will have access to it?

We understand that final domestic technology transfer regulations have not yet been issued. The Subcommittee is concerned that all final regulations implementing the Act be in place as soon as possible. We would appreciate your reporting back to us in 60 days on the status of these regulations.

The Subcommittee is looking forward to receiving a copy of the Inspector General's report on DOD implementation of the Federal Technology Transfer Act as soon as it is available. Again, thank you for your testimony.

Sincerely,

Doug Walgren

DOUG WALGREN
Chairman, Subcommittee on Science,
Research and Technology

DW:Wcw

Question: In your testimony you mention that the Department of Defense is developing a data base on areas of expertise within the DoD laboratories. When do you expect this data base to be fully operational? Who will have access to it?

Answer: The data base will be operational on August 1, 1989. The data base, known as the DoD Domestic Technology Transfer Referral Data Base, will be operated by the DoD's Defense Technical Information Center (DTIC). Anyone who has a specific technical area of interest concerning research conducted by DoD laboratories can contact DTIC. Anyone making an inquiry will be referred to the appropriate personnel in our laboratories compatible with the needs of the requestor. Inquiries can be made to:

Defense Technical Information Center
Office of Marketing and Product Management
DoD Domestic Technology Transfer Referral Data Base
Cameron Station
Alexandria, Virginia 22304
Telephone: (202) 274-6434

Question: We understand that final domestic technology transfer regulations have not yet been issued. The Subcommittee is concerned that all final regulations implementing the Act be in place as soon as possible. We would appreciate your reporting back to us in 60 days on the status of these regulations.

Answer: The DoD Regulation implementing the provisions of the Federal Technology Transfer Act of 1986 and Executive Order 12591, "Facilitating Access to Science and Technology" was issued in December 1988. A copy is provided for your information. We will request the Army, Navy, and Air Force to provide status or copies of their implementing regulations in 60 days as requested.

~~Attachmen~~t

DOD 3200.12-R-4

DEPARTMENT OF DEFENSE

DOMESTIC TECHNOLOGY TRANSFER PROGRAM REGULATION

DECEMBER 1988

UNDER SECRETARY OF DEFENSE
FOR ACQUISITION

50272-101

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D. Appler

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Under Secretary of Defense (Acquisition)
Washington, D. C. 20301

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11. Contract(C) or Grant(G) No.
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(G)

12. Sponsoring Organization Name and Address

13. Type of Report & Period Covered
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14.

15. Supplementary Notes

This Regulation cancels DoD 3200.12-R-4 dated Apr 85 (NTIS PB87 100269).

16. Abstract (Limit: 200 words)

This Regulation authorizes the DoD Domestic Technology Transfer Program and responds to the requirements of Public Law 96-480, the Federal Technology Transfer Act of 1986, and Executive Order 12591. Its purpose is to ensure the full use of the nation's federal investment in research and development (R&D), stimulating improved use by state and local governments and the private sector.

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See Instructions on Reverse

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

THE UNDER SECRETARY OF DEFENSE
WASHINGTON, DC 20301

ACQUISITION

27 DEC 1988

FOREWORD

This Regulation is reissued under the authority of DoD Directive 3200.12, "DoD Scientific and Technical Information Program," February 15, 1983. DoD 3200.12-R-4 "Domestic Technology Transfer Program Regulation," April 1985, is hereby canceled. This Regulation applies to all DoD components that perform or fund research and development (R&D) efforts that may be appropriate for transfer to state and local governments and to the private sector.

This Regulation authorizes the DoD Domestic Technology Transfer Program and responds to the requirements of Public Law 96-480, the "Stevenson-Wydler Technology Innovation Act of 1980," as amended by Public Law 99-502, the "Federal Technology Transfer Act of 1986" (reference (a)) and Executive Order 12591, (reference (b)) "Facilitating Access to Science and Technology." Its purpose is to ensure the full use of the nation's federal investment in R&D, stimulating improved use by state and local governments and the private sector.

The DoD Domestic Technology Transfer Program is separate and distinct from international technology transfer control programs, and nothing in this Regulation is intended to modify or rescind any of the responsibilities and procedures for technology transfer control stated in other DoD directives, instructions, and publications. This Regulation is effective immediately and is mandatory for use by all DoD components. Heads of the military departments shall issue supplementary documents within 90 days of the effective date of this Regulation. This is required by Public Law 96-480 Section 4 of reference (a), which defines each military department as a separate agency under the Act. Heads of all other DoD components may supplement this Regulation with additional documents as necessary to provide for any internal administration of this Regulation within their respective components.

Send recommended changes to this Regulation through channels to:

Director, Office of Research and Laboratory Management
Office of the Deputy DDRE (Research and Advanced Technology)
Office of the Under Secretary of Defense for Acquisition
The Pentagon
Washington, DC 20301-3080

DoD components may obtain copies of this Regulation through their own publication channels. Other federal agencies and the public may obtain copies from the U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

M. L. Lohr

Milton L. Lohr
Deputy Under Secretary

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Chapter 2. Reporting

REFERENCES

(a) Public Law 96-480, "Stevenson-Wydler Technology Innovation Act of 1980," October 21, 1980, as amended by Public Law 99-502, "Federal Technology Transfer Act of 1986," October 20, 1986
(b) Executive Order 12591, "Facilitating Access to Science and Technology," April 10, 1987
(c) Title 31, United States Code, Section 6303-6305, "Using Procurements, Grants and Cooperative Agreements"
(d) Title 35, United States Code, Section 1-376, "Patent Act"
(e) Title 7, United States Code, Section 2321-2583, "Plant Variety Protection Act"
(f) DoD Directive 2040.2, "International Transfers of Technology, Goods, Services and Munitions," January 17, 1984
(g) DoD Directive 5230.24, "Distribution Statements on Technical Documents," March 18, 1987
(h) DoD Directive 5230.25, "Withholding of Unclassified Technical Data from Public Disclosure," November 6, 1984
(i) DoD Instruction 5120.16, "Department of Defense Incentive Awards Program: Policies and Standards," July 15, 1974
(j) DoD Directive 2140.2, "Recoupment of Nonrecurring Costs on Sales of U.S. Products and Technology," August 5, 1985
(k) Title 5, United States Code, Section 4504 "Presidential Awards"

DEFINITIONS

Application Assessment. A summary emphasizing the potential application of each technological development from DoD R&D projects that has potential usefulness to State and local governments or private industry.

Cooperative Research and Development Agreement (CRDA). Any agreement between one or more Federal laboratories and one or more non-Federal parties under which the Government, through its laboratories, provides personnel, services, facilities, equipment, or other resources with or without reimbursement (but not funds to non-Federal parties) and the non-Federal parties provide funds, personnel, services, facilities, equipment, or other resources toward the conduct of specified research or development efforts that are consistent with the missions of the laboratory; except that such term does not include a procurement contract or cooperative agreement as those terms are used in 31 U.S.C. 6303-6305 (reference (c)) and as such the Federal Acquisition Regulation (FAR) and the DoD FAR Supplement are not applicable to these agreements.

Federal Laboratory. Any federally funded R&D facility that is owned, leased, or otherwise used by a Federal Agency and funded by the Federal Government, whether operated by the Government or by a contractor. A substantial purpose of such a facility or activity is the performance of research, development, or engineering by employees of the Federal Government or a contracted facility having such a prescribed Government purpose.

Federal Laboratory Consortium (FLC) for Technology Transfer. An organization of Federal Research and Development Laboratories and Centers chartered by P.L. 96-480 as amended by P.L. 99-502 (reference (a)) to identify and mobilize the necessary resources to provide the environment, the organization, and the necessary technology transfer mechanisms required to facilitate the fullest possible use of federally sponsored R&D results by both public and private sector potential users.

Government Inventor. For purposes of this regulation Government inventors are all employees of the Federal Government and military personnel.

Invention. As defined by reference (a) this is any innovation or discovery which is or may be patentable or otherwise protected under 35 U.S.C. (reference (d)), or any novel variety of plant which is or may be protected under the Plant Variety Protection Act, 7 U.S.C. 2321-2583, (reference (e)).

Office of Research and Technology Applications (ORTA). A function established in each DoD R&D activity to coordinate the Domestic Technology Transfer Program and to perform the actions specified in reference (a) and other responsibilities as outlined in this Regulation.

Research and Development Laboratory Budget. For the purpose of computing the monetary transfers required by Section 11 of reference (a) the research and development laboratory budget consists of all Program 6 "Research and Development" resources as defined in the DoD Planning, Programming, and Budget System that are allocated to the DoD Component's laboratories.

CHAPTER 1

THE DOMESTIC TECHNOLOGY TRANSFER PROGRAM

A. Policy

To achieve the maximum national benefit from DoD scientific and technical efforts as required by P.L. 96-480 and E.O. 12591 (references (a) and (b)), it is DoD policy to:

1. Encourage the dissemination of scientific and technical information, data, and know-how developed by or for the Department of Defense to State and local governments and to the private sector, consistent with the requirements of U.S. national security.

2. Promote the sharing of technology that fosters the advance of science or that has commercial potential and thus should be employed to best advantage for the security and socio-economic well-being of the United States.

3. Support coordination between the industrial, academic, and Government R&D activities of the United States by cooperating in the sharing of plans for future research efforts and the sharing of facilities as appropriate.

4. Support cooperative efforts to stimulate industrial innovation, especially in small businesses.

5. Support and encourage the exchange of scientific and technical personnel among academic, industry, and the DoD laboratories.

6. Support the domestic technology transfer process as an integral part of the R&D effort and incorporate domestic technology transfer objectives into the mission of each appropriate R&D activity.

7. Encourage domestic technology transfer in the workplace through its recognition in position descriptions, in promotion policies, in monetary awards, and in performance evaluations for appropriate scientific and engineering personnel.

8. Ensure that R&D activities have at least one full-time equivalent position responsible for performing the functions of an Office of Research and Technology Applications (ORTA) at any activity having over 200 full-time equivalent professional scientific, engineering, and related technical personnel. A full-time position for any activity with less than 200 professional scientific and engineering personnel is optional.

9. Ensure that domestic technology transfer functions do not compete substantially with similar services available in the private sector.

10. Ensure that the Domestic Technology Transfer Program does not conflict with export control regulations, policies governing militarily critical technology, policy requirements of recouping DoD nonrecurring costs, or any of the responsibilities and procedures for technology transfer control in DoD Directives, Instructions, and publications. Control policies are addressed in DoD

Directives 2040.2, 5230.24, and 5230.25 (references (f), (g), and (h)). Recoupment of nonrecurring cost policies are addressed in DoD Directive 2140.2 (reference (j)).

11. Identify and encourage persons to act as conduits between and among Federal laboratories, universities, and the private sector for the transfer of technology developed from federally funded R&D efforts.

12. Ensure that State and local governments, universities, and the private sector are provided with information on the technology, expertise, and facilities available in Federal laboratories.

B. Responsibilities

1. The Under Secretary of Defense for Acquisition (USD(A)) shall:

a. Establish departmental policies and procedures for domestic technology transfer.

b. Coordinate interservice activity under the Domestic Technology Transfer Program.

c. Cooperate with other Federal agencies, particularly the Department of Commerce and the National Science Foundation, to maximize the effectiveness of federal domestic technology transfer efforts.

2. The Heads of DoD Components shall:

a. Designate, at the Headquarters level, a point of contact for domestic technology transfer activities who shall participate with the appropriate ORTAs from the DoDs laboratories as a voting member in the Federal Laboratory Consortium (FLC).

b. Be authorized to license, assign, or waive rights to intellectual property developed by the DoD laboratories through cooperative R&D agreements or solely within or under the direct control of the laboratories.

c. Ensure review by legal counsel of the DoD Components and/or activities of CRDAs for consistency with the standards of conduct requirements before final approval and participation in a CRDA. As prescribed by P.L. 96-480 (reference (a)) a Headquarters level review must be completed within 30 days of submission by the DoD laboratory.

d. Specify the appropriate R&D activities that may require a full-time equivalent position to be responsible for performing the ORTA functions. This includes any activity having 200 or more full-time equivalent professional scientific, engineering, and related technical personnel.

e. Provide for the participation of ORTA designated personnel in appropriate management development programs.

f. Transfer through the National Institute for Standards and Technology for use by the FLC on an annual basis, from fiscal year 1987 to 1991, an amount equal to eight thousandths of one percent (0.008%) of the Components' R&D laboratory budget that is to be used by the laboratories of the Component as defined in this regulation.

g. Cooperate with other Federal Agencies to maximize the effectiveness of Federal domestic technology transfer efforts.

h. Establish an ORTA at laboratories and other activities to perform, as a minimum, the domestic technology transfer functions specified in this Regulation. Each ORTA shall:

(1) Perform the following functions as specified in P.L. 96-480 and P.L. 99-502 (reference (a)).

(a) Prepare an application assessment of selected R&D projects that have potential commercial applications.

(b) Provide and disseminate information on federally owned or originated products, processes, and services having potential application to State and local governments and to private industry.

(c) Cooperate with and assist the National Technical Information Service (NTIS), the FLC, and other organizations that link the R&D resources of that laboratory and the Federal Government as a whole to potential users in State and local government and private industry.

(d) Participate, where feasible, in regional, State, and local programs designed to facilitate technology transfer for the benefit of the region, State, or local jurisdiction in which the activity is located.

(2) Participate in appropriate activities of the public and private sector that provide the opportunities to achieve technology transfer objectives; e.g., local government meetings or small business conferences.

(3) Assist program managers and technical department heads in identifying technologies suitable for transfer and for which application assessments need to be developed.

(4) Coordinate domestic technology transfer activities with patent counsel to determine rights to technical data, patent and licensing implications, and the commercial potential of patentable technology.

(5) Ensure that no domestic technology transfer functions substantially compete with similar services available in the private sector.

(6) Ensure that no domestic technology transfer functions conflict with export control regulations, policies governing militarily critical technology, or any of the responsibilities and procedures for technology transfer control in DoD Directives, Instructions, and publications.

i. Encourage and cooperate with the establishment of technical volunteer programs as a resource to complement and support domestic technology transfer activities.

j. Establish a mechanism for coordinating domestic technology transfer efforts with Small and Disadvantaged Business Utilization Specialists for the purpose of stimulating commercialization of appropriate technologies by small business.

k. Make available for use within the Component not less than one half of one percent,(0.5%) of the total R&D budget, to support the domestic technology transfer functions of that Component as specified in Section 11 of P.L. 96-480 (reference (a)). This provision may be waived by notification to Congress on an annual basis at the same time as the budget submission to the Congress including explanation of reasons for the waiver and alternate methods of conducting the technology transfer function.

l. Document and input a description of all CRDAs to the Defense Technical Information Center (DTIC) Work Unit Information System within 30 working days of the initiation of such agreements.

m. Maintain permanent records of all CRDAs at Components or their designated activities.

C. Principles

The principles of the domestic technology transfer program as established by the DoD Components must include but are not limited to the following:

1. DoD Components and their Government-operated laboratories may enter into CRDAs. Within CRDAs, and subject to national security limitations, DoD Components may:

a. Be party to an agreement that includes other Federal Agencies, State and local governments, industrial organizations, public and private foundations, nonprofit organizations, or other persons (including licensees of inventions owned by the Federal Agency). Such agreements, to the maximum extent possible, shall give special consideration to small business firms and consortia involving small business firms, and give preference to business units located in the United States that agree that products embodying inventions made under a CRDA or produced through the use of such inventions will be manufactured substantially in the United States and, in the case of any industrial organization or other person subject to the control of a foreign company or government, take into account whether or not such foreign government permits U.S. agencies, organizations, or other persons to enter into CRDAs and licensing agreements.

b. Provide personnel, services, facilities, equipment, or other resources with or without reimbursement (but not funds to non-Federal parties), and non-Federal parties may provide to the laboratory funds, personnel, services, facilities, equipment, or other resources toward the conduct of specified research or development efforts that are consistent with the mission of the Component's activity.

c. Grant or agree to grant in advance, to a collaborating party, patent licenses or assignments, or options thereto, in any invention made in whole or in part by a Federal employee under the agreement, retaining a nonexclusive, nontransferable, irrevocable, paid-up license to practice the invention, or have the invention practiced throughout the world by or on behalf of the Government and such other rights as the DoD Component and/or activity deems appropriate.

d. Waive, subject to reservation by the Government of a nonexclusive, irrevocable, paid-up license to practice an invention or have an invention practiced throughout the world by or on behalf of the Government, in advance, in whole or in part, any right of ownership which the Federal Government may have to any subject invention made under an agreement by a collaborating party or employee of a collaborating party.

e. To the extent consistent with established DoD Component requirements, standards of conduct, and subject to national security considerations, permit employees or former employees to participate in efforts to commercialize inventions made while in U.S. Government service.

f. In addition the principles stated in paragraphs C.1.a. through e. above, where appropriate, shall apply to the patenting and licensing of Government inventions that are accomplished independent of a CRDA.

2. Awards

a. Within the appropriate awards programs as established by DoD Instruction 5120.16 (reference (h)), the DoD Components shall establish and promote appropriate monetary and professional excellence recognition of Federal employees who contribute materially to the objectives of the domestic technology transfer program. Such awards shall include recognition of:.

(1) Inventions, innovations, or other outstanding scientific or technological contribution to the missions of the Components, their activities and/or throughout the Federal Government.

(2) Exemplary activities that promote domestic transfer of science and technology development within the Federal Government and result in the use of such science and technology by American industry or business, universities, State or local governments, or other non-Federal parties.

b. Such awards shall not be given in place of or in lieu of any monetary gain obtained by current or former employees as a result of royalties, licenses, or the other such agreements as negotiated under the guidelines of this program.

3. Distribution of royalties or other income received by DoD Components

a. Royalties or other income received on account of any invention shall be payable to the inventor(s), if such persons were employed by the Agency at the time of the invention. Such payments shall continue as long as the Agency receives economic benefit regardless of the inventor's future employment status. If an invention is licensed for commercial use, and if royalty or other income results from the license, the Government inventor(s) are to receive income as prescribed in the remainder of this paragraph. If the income received by the Government is less than $1000 times the number of inventor(s), (one or more), the Government inventor(s) shall receive the entire amount of income in equal shares. If the income is greater than $1000 times the number of Government inventor(s), the inventor(s) shall share equally 20% of the total income or $1000 each, whichever is greater, and subject to the conditions prescribed in subsection C.2., above. Inventor(s) employed by the agency at the time the invention was made shall receive payment of their prescribed share of any royalties or other income received by the Government on an annualized basis.

b. Payments of royalties or other income from inventions to an employee shall not exceed $100,000 per year without Presidential approval as provided in 5 U.S.C. 4504 (reference (k)).

c. Government inventors shall be entitled to income as discussed in this section for all income derived by the Government starting October 20, 1986, the effective date of P.L. 99-502 (reference (a)). This applies to royalties or other income received for inventions since that date regardless of the date of the invention.

d. Assignment and use of income should be applied in accordance with the following schedule:

(1) It must be used within the fiscal year received plus the succeeding year.

(2) It should be used principally by the activity that participated in the development of the invention.

(3) After assignment of royalties or other income to inventors under paragraph C.3.a. above, income may be used for:

(a) Payment of expenses incidental to administration and licensing of inventions.

(b) Reward of scie~~ntific, engi~~neering, and technical employees at that activity.

(c) Promotion of scientific exchange among other activities of the DoD Component.

(d) Education and training of employees consistent with the R&D mission and objectives of the Department of Defense.

(e) Other activities that increase the licensing potential for transfer of the technology of the Government laboratory.

e. DoD Components shall develop criteria and guidelines with timeframes for Government participation with inventors and/or for instances for which it is appropriate for Government to relinquish patent and licensing rights to inventors. Criteria for determining the sharing of rights with multiple inventors also shall be specified.

CHAPTER 2

REPORTING

As specified in PL 99-502 (reference (a)), each DoD Component shall provide an annual report to Congress, as part of their input to the annual DoD budget submission. The report shall include summaries of the amount of royalties and other income received and expenditures made, including inventor awards.

Question: The Subcommittee is looking forward to receiving a copy of the Inspector General's report on DoD Implementation of the Federal Technology Transfer Act as soon as it is available.

Answer: We have requested the DoD Inspector General to provide a copy of the final report to the Subcommittee when it is issued.

TECHNOLOGY TRANSFER: A PROFILE OF AGENCY ACTIVITIES IN USDA

Submitted by the
Technology Transfer Subcommittee of the
Research and Education Committee
U.S. Department of Agriculture

Revised March 1989

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Research and Education Committee

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Revised March 1989

Technology Transfer in USDA
A Summary of Activities

Technology transfer, broadly defined as "getting the results of research into the hands of those individuals and organizations who can put it into practical use" has long been a thrust of USDA Agencies. However, the Technology Innovation Act of 1980 (P.L. 96-480) and the Technology Transfer Act of 1986 (P.L. 99-502) gave additional emphasis to this role for all Federal agencies. This was emphasized further by Presidential Executive Order 12591 entitled "Facilitating Access to Science and Technology" which was issued by President Reagan on April 19, 1987.

The Assistant Secretary of Agriculture for Science and Education was delegated the authority to coordinate USDA technology transfer activities and in December 1986 formed the Technology Transfer Subcommittee under the auspices of the USDA Research and Education Committee. The objectives of this Subcommittee are to:

- Serve as a focal point for interagency cooperation in coordinating and fostering joint technology transfer efforts.
- Identify potential policy issues and their ramifications for technology transfer within USDA.
- Serve as a forum for interagency awareness (information sharing) on planned or ongoing technology transfer efforts by the respective agencies.
- Identify joint technology transfer opportunities and develop mechanisms for creating, funding, and facilitating these efforts at national, regional, and field levels.

Eighteen USDA Agencies and organizations elected to become members of the Technology Transfer Subcommittee. They are:

- Agricultural Marketing Service (AMS)
- Animal and Plant Health Inspection Service (APHIS)
- Agricultural Research Service (ARS)
- Cooperative State Research Service (CSRS)
- Economic Research Service (ERS)
- Extension Service(ES)
- Federal Crop Insurance Corporation (FCIC)
- Federal Grain Inspection Service (FGIS)
- Food and Nutrition Service (FNS)
- Forest Service (FS)
- Food Safety and Inspection Service (FSIS)
- Human Nutrition Information Service (HNIS)
- National Agricultural Library (NAL)
- Office of General Counsel (serve as counsel only) (OGC)
- Office of Governmental and Public Affairs (OGPA)
- Office of International Cooperation and Development (OICD)
- Soil Conservation Service (SCS)
- World Agricultural Outlook Board (WAOB)

This report Technology Transfer: A Profile of Agency Activities in USDA is a result of a cooperative effort among member agencies of the USDA Technology Transfer Subcommittee. For additional information on USDA efforts and accomplishments in technology transfer contact:

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SAMPLING OF TECHNOLOGY TRANSFER ACTIVITIES IN USDA

The following are abbreviated mission statements and brief illustrations of technology transfer activities conducted by agencies within the U.S. Department of Agriculture.

Agricultural Research Service

ARS conducts basic and applied research pertaining to soil and water conservation, plant sciences, animal sciences, commodity conversion and delivery, human nutrition, and integration of agricultural systems. The following are examples of accomplishments for 1988:

- 28 patents granted to ARS.
- 18 patent licenses issued to industry firms.
- Inventions reported totalled 139, an increase of 83% over the previous year.
- 45 Cooperative Reasearch and Development Agreements signed with industry firms, and another 40 being negotiated.
- 3600 reports on new research findings described on the ARS computerized TEKTRAN system (Technology Transfer Automated Retrieval System) and made available to industry firms, Cooperative Extension Services and government agencies.

Animal and Plant Health Inspection Service

APHIS conducts research and development in such areas as pest eradication, treatment of animal diseases, animal damage control and biocontrol. Recent accomplishments include:

- Development of monoclonal antibody transferred to industry for the veterinary medicine market.
- Toxicant for control of roosting blackbirds.
- Technology to control predation on livestock.

Cooperative Extension System

The Extension Service is the USDA agency most directly associated with a technology transfer mission. As a model public sector technology transfer system, Extension networks with user groups to identify needs for new technology, integrates knowledge and technologies into user-oriented packages, and educates clientele to implement technology packages. Recent examples of technology transfer include:

- Establishment of Research Results Data Base which delivers USDA research findings prior to "official" publication.
- National Wood Products Extension Program (NWPEP), a joint project with the Forest

Service's Forest Products Laboratory, provided lumber drying workshops in Pennsylvania. These saved the industry $271,000.

- 4 North Carolina firms use wood residues to save $450,000 per year in fuel costs.
- A survey of homeowners revealed that 336 of 12,000 Texans saved $35,000 from applying information received from Extension.
- GOSSYM-COMAX, a computer-based simulation of cotton growth and yield, is being tested to determine if it can provide reliable and accurate information for onfarm use.
- Interdisciplinary chemigation task force appointed in Nebraska.

Cooperative State Research Service

In recent years, the Special Projects Unit in CSRS has been bridging the gap between research results and commercialization with demonstration projects. The identified projects began in 1986:

- Kenaf Demonstration Project began with a cooperative agreement with a venture capital firm. The project's objective was to gain acceptance for kenaf as a source fiber for the manufacture of newsprint. As a result of the demonstration, a $300 million kenaf newsprint mill will be constructed and 40,000 acres of unsubsidized kenaf will be needed to fill the mill's needs.
- Under a guayule domestic rubber project, the Department of Defense is providing $11 million to build and operate a prototype processing plant that will process 275 acres of guayule shrub into 50 tons of natural rubber, 100 tons of resin and low molecular weight rubber, and 1,600 tons of plant residue. Private sector, land grant universities and USDA are investing in this project.
- The market potential for the Hybrid Striped Bass is promising. Because of a moratorium on striped bass fishing in the Chesapeake Bay, there is an immediate market shortfall of 14 million pounds. Private and government marketing experts estimate a beginning market of 54 million pounds -- equal to that of trout. At that production level, producers' gross income would be about $182 million.

Economic Research Service

ERS' technology responsibilities involve economic analysis of the potential for new technologies to affect agricultural policies, commodity production and trade, financial well-being of the farm sector and rural economies, and agricultural resource utilization. Issues recently examined are:

- National, regional, and farm-level impacts of bovine somatropin (bST) also referred to as bovine growth hormone (bGH) and its effects on the dairy industry.
- Livestock growth hormones and the potential impacts of growth hormone adoption on feed and grain demand, land use, farm income, international competitiveness, and on food safety and product quality.
- Cost and competitiveness of the ethanol industry and the potential for new technologies to reduce production costs.

Federal Grain Inspection Service

FGIS is presently developing systematic methods of transferring technologies to the grain inspection system which, when implemented, will provide sound and objective testing procedures to facilitate the efficient marketing of grain and grain related products. A task force was formed to determine the best means of transferring the most effective technologies available to the grain inspection system. A prime example of a successful transfer includes:

- Near Infrared Reflectance instrumentation was developed by the Agricultural Research Service and refined by the private sector to meet the needs of FGIS and the grain industry. The instrument which provides a quick analysis of grain moisture, protein, oil, and fiber, without classical wet chemical methods, is now being produced by the private sector.

Food Safety Inspection Service

FSIS is responsible for the safety, wholesomeness, and accurate labeling of meat and poultry products. Most of the agency's technology transfer activities are relative to the development and commercialization of rapid diagnostic tests. FSIS has a Technology Transfer and Assessment Staff which assesses emerging technologies and facilitates transfers. The examples trace a ten-year history of technology transfer activities:

- Swab Test for use On Premises (STOP) was developed to determine the presence of antibiotics and residues in animal tissues.
- A similar test was developed for the detection of sulfonamides in calves, Calf Antibiotic Sulfa Test (CAST). What started out as an FSIS "quick test" developed into the nucleus of a small commercial business.
- One entrepreneur recognized the market for these rapid diagnostic tests and subsequently developed a rapid and portable card test for gentamicin. The FSIS Microbiology Division purchased the cards and worked out the prototcols for agency use.
- At least a dozen (12) rapid diagnostic tests have resulted from FSIS and the private sector's working together.

Forest Service

FS technology transfer programs embrace everything from fire prevention to a wide array of bio-technology and genetic engineering, from utilization of forest products and incentive programs for small woodland owners to computer analysis systems and new organizational management techniques. Examples of Forest Service transfers include:

- Laminated wood bridge deck technology can replace either structurally or functionally deficient bridges with savings of 1/3 to 1/2 the cost of current replacement expenditures.
- Forests in the Pacific islands of Micronesia and American Samoa are crucial as they

protect soils, shorelines, fisheries and fresh water supplies. FS has concentrated efforts on the development of forestry personnel from over 10 different governments: education, on-site seminars and personnel exchange are a few methods of technology transfer used.

- 7 formal technology transfer agreements with various non-federal parties.
- Partnership was formed with a vendor to implement the National Information Management Network.

Human Nutrition Information Service

HNIS conducts research on food consumption, dietary survey methodology, food composition, nutrition knowledge and attitudes, and dietary guidance and nutrition education techniques. Primary users of the information are nutrition and health professionals, including the private sector. Three major areas of focus are:

- National Nutrient Data Bank, the most comprehensive data on the nutrient composition of foods, is developed through research and cooperation with industry, trade and outside agencies.
- Nationwide Food Consumption Survey data used in research, education and food program planning.
- Dietary guidance and nutrition education resources are distributed to nutrition and health educators, and the general public.
- Research and education resources are used by private sector firms to develop such products as textbooks and computer software packages.

National Agricutural Library

NAL is responsible for the organization and dissemination of agriculturally-related information to a variety of end users. Although the Library is not often thought of as having a role in technology transfer, it is often the starting point for researchers. Several examples of recent activities include:

- The expansion of the national collection to include the subject of technology transfer itself, as well as other related areas of economic competitiveness, innovation, leadership and critical thinking, taking charge, and state technology programs.
- A biotechnology firm needed information on nutrition, feed formulation, and worldwide markets for cultured salmon. Using the technical assistance provided by NAL, the company marketed its product and estimated a sales potential of $75 to $100 million annually.
- A group of Federal water quality experts, including some outside of USDA, are experimenting with an electronic communication Networking system to increase their collaborative efforts.

Office of Governmental and Public Affairs

Office of Information

OI coordinates the transfer of new technology over the entire department. Information the Department or its agencies deem of national importance is turned over to OI for release. 1988 Results of OI's coordinating efforts include:

- 1,757 national press materials released.
- Weekly Radio Services, containing four weekly series, was distributed to nearly 1,000 radio stations and networks. A fifth, Hispanic Information Service was distributed to more than 200 stations.
- 3 weekly television programs were broadcast by satellite.
- 1400 audio teleconferences linked people across the country to discuss department research and programs.

Office of International Cooperation and Development

OICD's cooperative programs with countries worldwide promote the transfer of new technology, knowledge, information, and skills beneficial to U.S. agriculture and other countries. The following are recent accomplishments of transferring technology into the United States:

- Research with Yugoslavia and Poland led to the discovery of four insect parasites which are capable of controlling the cereal leaf beetle. The parasites were released in the U.S. and subsequently reduced the cereal leaf beetle problem to one of minor importance. Control of this beetle by chemical means would have cost $100 million in the U.S.
- Trait for resistance to the white rot disease in onions has been transferred (from Egypt) to several commercial cultivars in the U.S.
- The technique (from Israel) for control of soilborne pests by solar heating of soils was refined and used on U.S. pistachio and vegetable crops. Estimated value of this technology transfer is about $31 million.
- Examples of U.S. technology transferred to other countries include the low-cost extrusion cooker for use in manufacturing nutritious supplementary food products, and the alleviation of the grasshopper/locust threat in northern Africa.

Soil Conservation Service

SCS's basic mission embodies the effective, efficient transfer of soil and water conservation technology to land users. The agency has just completed an in-depth study of technology management and has also identified 3 main initiatives to improve technology transfer to the public. The following are recent accomplishments:

- Computer Assisted Management and Planning System uses data processing techniques and database management systems with application software to assist in planning and installing soil and water conservation practices.

- Engineering and/or economic handbooks, manuals or software programs are available through NTIS.
- In 1985, commercial production of SCS releases amounted to 7 million pounds of seed and 9.4 million plants. The retail value of both seed and plants was about $25 million.

AGENCY REPORTS

AGRICULTURAL RESEARCH SERVICE

Major activities in Technology Transfer conducted by the Agricultural Research Service (ARS) are: 1) direct communication between scientists and users; 2) involvement of users and potential users in research planning and evaluation; 3) cooperative research and development agreements with industry firms; 4) direct transfer of new ARS research findings via computer to industry firms, action agencies, National Technical Information Service, State Extension Services, the National Agricultural Library, and State and local governments; 5) patenting and patent licensing; 6) research reporting by ARS Information Staff, and 7) participation in and support of the programs of the Federal Laboratory Consortium for Technology Transfer.

During the past year, emphasis has been given to Cooperative Research and Development Agreements with industry, and patenting and patent licensing. **Twenty-eight patents** were granted ARS this past fiscal year, and **patent licenses** issued industry firms reached eighteen. Even more are expected in the future since new **inventions** reported by ARS scientists (but not yet patented) were **up 83 percent** in FY 88 to a total of 139. **Cooperative Research and Development Agreements** signed with industry firms to date total about 45 with another 40 being negotiated. Also several hundred industry firms and other users (including all State Cooperative Extension Services) have direct access to the latest ARS research findings via the computerized TEKTRAN system. TEKTRAN (Technology Transfer Automated Retrieval System) electronically collects, stores, and makes possible direct retrieval by users the more than 3,600 reports on new research completed by ARS scientists each year.

ARS scientists make more than 60,000 contacts with users and user groups each year to facilitate transfer of technology developed by the agency. For example, industry personnel have an estimated 13,000 contacts with ARS scientists yearly. One method of achieving contacts with industry is through technology transfer meetings at ARS locations (see attachment I).

As a result of continued contact with industry ARS has been able to successfully transfer many new technologies. A listing of some current examples follows.

- New Instrument for Measurement of Soil Salinity - An instrumental method for measuring soil salinity directly without the need for soil sampling and laboratory analysis.

- Biodegradable Plastics from Corn - Utilizing cornstarch for commercial production of biodegradable plastic.

- Meter Measurement for Fat in Humans - Utilizing near infrared technology and computer techniques to measure the percentage of fat in the human body.

- Soil-Aquifer Treatment (SAT)for Purification of Sewage Effluent - A method to purify partially treated sewage and make the rejuvenated effluent recoverable for irrigation, recreation, and other uses.

- New Forage System for Lower Cost-Production - The introduction of warm season grasses and cool season grasses into forage systems which extends the pasture seasons in certain areas.

- Methods to Detect Adulteration of Food Products - The use of carbon isotopes to detect the adulteration of orange juice, apple juice, and honey with less expensive sugar products.

- Cotton Stalk Shredding for the Control of Boll Weevil - Early shredding of old cotton stalks immediately after harvest significantly lowers the percentage of boll weevils that over-winter.

- Cold Treatment for Citrus to Replace Fumigation - Six million boxes of grapefruit were treated successfully and exported to Japan in 1988 utilizing this treatment.

- Recommended Dietary Allowances for the United States - The Food and Nutrition Board of the National Academy of Sciences, utilized ARS research results in setting these allowances.

- Calorie Free - High Fiber Flour Substitute - This product is currently being used in bakery goods for diet conscious consumers.

A beginning point for transfer of new technology developed by ARS is communicating research results to the public. Frequently using TEKTRAN summaries as a starting point, science reporters obtain further information from scientists and write news releases, articles for AGRICULTURAL RESEARCH magazine, short items for the QUARTERLY REPORT TO CONGRESS and the annual RESEARCH PROGRESS REPORT, a radio and television news features, speeches for ARS leadership, and a quarterly roundup of reports of special interest to business and industry people. All such stories are sent to media and industry contacts who have indicated in writing that they want to receive them.

ATTACHMENT 1

Technology Transfer Meetings

The objective of these meetings are to make the industry more aware of the kinds of ARS research that is done in ARS laboratories, what some of a the accomplishments that may be sitting on the shelf waiting to be picked up, what facilities are available, and what scientific expertise is available at that laboratory. It is also to make ARS scientists think in terms of the users of their research and to enhance existing or develop new rapport with those users. Ultimately, ARS would like to see its scientists get to know, on a first name basis, important people in industries that will use their research. Our goal is to have at least one technology transfer meeting at each sizable location over the next 2 years. The subject matter of the meetings held in FY 87 and FY 88 include:

- Corn Quality and Large-Volume Product Markets
- Improved Rangeland and Its Effect on Livestock Performance
- Poultry Nutrition
- Genetic Improvement of Chickens; Vaccine Development for Poultry Diseases; Poultry Diagnostic Kits
- Citrus Research
- Dairy Products Research
- Inhibitors for Enzymatic Browning of Fruits and Vegetables
- Floral and Nursery Crop Research
- Near Infrared Analysis of Feedstuffs
- Grain Quality
- Non-Food Use of Cereal Grains
- Meat Safety
- Control of Nitrate
- Sustainable Agriculture
- Improvement and Control of Poultry Body Composition
- Sulfite Alternatives
- Freeze Concentration of Dairy Products
- Dryland Agriculture
- Catfish Production
- Potential for Kenaf Production in Oklahoma
- Peanut Quality

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ANIMAL AND PLANT HEALTH INSPECTION SERVICE

The technology transfer activities in the Animal and Plant Health Inspection Service (APHIS) occur primarily with APHIS's Science and Technology (S&T) which comprises the National Veterinary Services Laboratories (NVSL), Ames, Iowa; the Denver Wildlife Research Center (DWRC), Denver, Colorado; the National Monitoring and Residue Analysis Laboratory, Gulfport, Mississippi; and the APHIS Methods Development Centers.

Technology Transfer activities conducted by APHIS/S&T include: (1) novel analytical methods used for detecting pesticide residues and toxic substances in National Monitoring Surveys and pest eradication programs; (2) development of novel methods for evaluation of veterinary biological products used in the diagnosis, prevention, and treatment of animal diseases; (3) development of animal damage control tools including chemical, physical, and biological or cultural approaches; and (4) development of biocontrol approaches and programs for control of insects and noxious weeds.

Examples of APHIS/S&T Technology Transfer:

- Multi-residue analysis of tobacco - Used for residue analysis of acid herbicides, chlorinated hydrocarbons, formothion, selected fumigants, and synthetic pyrethroids in tobacco. Methodology made available to other Federal and State laboratories, universities, and private industry.

- Oligonucleotide DNA Probes - developed in cooperation with Iowa State University. Used to probe for specific DNA sequences within the thymidine kinase gene of strains of vaccine virus. This probe is provided to the biologics industry for characterization of IA virus.

- Anti-porcine immunoglobulin monoclonal antibodies developed in cooperation with the Agricultural Research Service. Patented product is made available to the biologics industry.

- Mass trapping for eradication - Development of the basic parameters and guidelines for utilizing mass trapping as a technique for eradicating isolated infestations of gypsy moth. It is widely used in Federal and State Programs.

- Methodology for aerial application of insecticide-bait for Mexican fruit fly control - Developed methodology and equipment need for applying ultra low volume insecticide-bait mixture. Method currently being used by State and Federal government programs, foreign governments and private industry.

- Development of monoclonal antibody based in vitro antigen quantitation technology - developed by NVSL and transferred to several biologics licensees for viral vaccines to eliminate host animal tests for serial release. Examples include infectious bovine rhinotracheitis, parainfluenza 3, porcine parvovirus, and pseudorabies virus.

- Surfactant, P-44, for control of blackbirds - DWRC developed and registered by the EPA to control roosting blackbirds. Before development of this toxicant, control depended upon aircraft application and precipitation at the time of application which greatly restricted control.

- Technology to control coyote predation on livestock - DWRC has written and distributed manuals for the use and maintenance of the M-44 device for coyote predator control on livestock. This manual is widely used by Animal Damage Control specialists and by Federal and State governments as well as industry.

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COOPERATIVE EXTENSION SYSTEM

Mission

The Extension Service is the USDA agency most directly associated with a technology transfer mission. The agency is the Federal partner in the national Cooperative Extension System, which is widely viewed as **"a model public sector technology transfer system"**.

Extension performs three major roles in the technology development and transfer process:

- Extension concentrates on building and maintaining **extensive networks linking** users, **researchers, private sector marketers of technology, and interest groups** for the purposes of setting program priorities, identifying problems (needs for new technology), and contributing to the development and implementation of new technology.

- Extension **integrates practical knowledge and technologies into user-oriented** packages which also include combining appropriate marketing and management elements. It coordinates with research, regulatory, and action agencies and others to assess and adapt these technology packages and incorporate them into educational programs for use under a variety of conditions, including size and type of farm, managerial ability of the farm operators and geographic region of the country.

- Extension transfers technical knowledge regarding the use of technologies, practices and technology packages. Compared with research and regulatory agencies and private firms, Extension places **primary emphasis on educating users to evaluate, select, integrate and implement technology packages**.

Examples of Transferred Technology

Research Results Data Base. A number of databases are currently available and speed the education process through dissemination of both general and specialized research results. **Through a new research results data base (RRDB), specialists in the land grant university system have early access to USDA research findings** to use in addressing problems of farmers, ranchers and agribusiness firms. Through the joint efforts of ES, ARS and ERS, research findings are summarized on a national data system prior to "official" publication. Although this system has been available nationally only since January 1, 1986, Extension specialists in more than 40 states are already using it. About 4,000 reports of new research findings are currently entered in the data base. In the first 6 months of 1986 over 12,000 "keyword" searches were made on the system.

National Wood Products Extension Program. Thanks to a cooperative agreement between ES-USDA and the Wisconsin Cooperative Extension Service with support from the Forest Service Forest Products Laboratory at Madison, a strong link has been forged between Extension and Forest Service wood products research. The National Wood Products

Extension Program (NWPEP) has the purpose of delivering wood products technology to Extension audiences through the traditional Extension delivery system. Extension personnel work at the U.S. Forest Service Forest Products Laboratory (FPL) with researchers to translate research findings into everyday language for use by Extension.

In the Midwest and Southeast, NWPEP promoted the **Saw-Dry-Rip (SDR) process**, which results in lumber for houses from under-utilized hardwoods.

FLP researchers developed a **color test procedure to separate white oak from red oak.** This test now facilitates export trade with European Economic Community (EEC) countries, **eliminating costly fumigation requirements.** NWPEP also provided timely updates on revised federal regulations.

The financial gains or savings from applying the technology of wood use are impressive. **Proper drying of wood** has prevented huge losses wherever dry kiln operators have been trained by Extension. For example, **the 1985-86 attendees of Pennsylvania hardwood lumber drying workshops saved the industry $271,000 through improved lumber quality. Four North Carolina nonwood businesses capitalized on the latest technology from Extension, of using wood residues and they are now saving $450,000 per year in fuel costs.**

Although individual homeowners do not save large amounts from better use of wood, the collective saving of groups of homeowners through proper painting, refinishing, rehabilitation, and do-it-yourself, is likewise impressive. **A sample of just 336 of 12,000 Texans showed they saved $35,000 from applying information received from Extension.** If this average savings of over $100 each could be projected to all 12,000 receiving the training, collective savings from application of this technology would be over $1 million in Texas alone.

Computer Simulation of Cotton Growth and Yield. GOSSYM-COMAX is a computer-based simulation of cotton growth and yield being tested to determine if it can provide reliable and accurate information for onfarm use. **And GOSSYM is one of the best examples of the transfer of technology from research to the "real world."**

Cotton farmers, make daily decisions about their crop. When for example, cotton seedlings are blasted by blowing sand, the farmers must decide if the yield of a replanted crop would more than pay for the cost of replanting. When the weather turns dry, they need to schedule irrigations to maximize profits.

In the past, this type of decision has been based on experience, certainly, but also on custom, rule of thumb, or "gut feeling." For example, most farmers replant cotton when the stand "looks" too thin. GOSSYM was designed so that decisions like these could be based on more information, including soil fertility, moisture content, and weather information.

GOSSYM-COMAX is the result of over 15 years of collaboration among many organizations. The joint venture has been led by USDA-Agricultural Research Service (ARS), Clemson University (SCAES), and Mississippi State University (MAFES). Extension Service-USDA (ES), ARS, SCAES, and MAFES have agreed to work together to continue the beltwide implementation of GOSSYM-COMAX based upon positive responses received from the 1986-88 pilot effort. This pilot effort was jointly funded by the two agencies plus state funds and support from the Cotton Council. The purpose of the pilot was the extend GOSSYM-COMAX to a broader base of growers.

Water Quality. Chemigation is a term that describes a process of applying agricultural chemicals by mixing them with irrigation water. In Nebraska, concerns arose that insecticide use for chemigation might increase the potential for groundwater contamination. At the height of the irrigation expansion in 1982-83 for example, the Nebraska corn crop experienced unusually heavy infestations of corn borer. In 1983 alone, producers chemigated more than 200,000 acres with insecticide in efforts to control this costly pest.

In response to groundwater contamination fears, **the Nebraska Cooperative Extension Service appointed an interdisciplinary chemigation task force**, which has taken several actions under the national Extension water quality initiative:

- conduct workshops for state and local agencies to discuss chemigation issues.
- update a fact sheet on chemigation antipollution equipment.
- develop a fact sheet on applying insecticides through center pivots.
- conduct an in-service training session for all Extension agricultural agents.

Housing Technology. The Alaska Craftsman Home Program provides a voluntary education service which informs homebuilders of methods to reduce the thermal requirements of a residence. The energy savings that can be achieved is only one benefit of an education network allowing research and field application experience to be systematically exchanged within the Alaska housing industry. The program is designed to provide: technical information for the industry; and a forum for the industry to help determine objectives for the State Finance and University Research Community.

The Cooperative Extension Service and State Division of Community Development jointly initiated the program in 1986. A pilot series of building seminars was held in March, 1986. One hundred and three shelter industry people were introduced to the "superinsulation" building techniques through the Super Energy Efficient Home Workshop Series taught by internationally acclaimed experts.

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COOPERATIVE STATE RESEARCH SERVICE

Public supported agriculture research and education have always had a close working relationship with producers of food, fiber, and forest products. Most of the effort has been on production -- increasing yield per acre, animal unit, or hours of labor. That was fine when the United States fed, clothed, and sheltered its own citizens and exports were continually expanding. We now must compete on the world scene. We import $20.1 billion of agricultural products (which has doubled the last ten years); plus $13.3 billion for forestry products; $4.8 billion for edible fish and shellfish; and more for imported industrial feedstocks that could be obtained from U.S. farms and forests. For 1987, the value of agricultural, fish, and forest product exports was #36.3 billion, down 31 percent from 1981.

For 1988, the outlook looks better. The value of agriculture exports is forecast to climb $4.1 billion from 1987 (USDA projections). Increased sales are expected in grains, soybeans and horticulture products. This is good news for farmers, but it is unlikely the 1981 record levels can be attained in the near future. Primary reasons include: the relative value of the U.S. Dollar has fallen significantly as compared to the Japanese yen and many Western European currencies, but has changed little in comparison to major agriculture exporting nations like Canada, Brazil, and Australia; expanded food producing capacity in countries like China & India; import restrictions in Asian and West European markets; aggressive targeting of U.S. markets by many countries; and lack of foreign exchange in less developed countries -- where the largest growth in population is occurring.

On April 4, 1987 Congressman Larry Hopkins told his constituents in central Kentucky, "Farmers must diversify into alternative enterprises." Gross income from tobacco sales in Kentucky was cut in half between 1984 and 1986, and corn income was down 40.5 percent. Similar questions are being asked by sugarcane farmers in Hawaii (world price of sugar is now one-third the domestic price), corn producers in Nebraska, wheat farmers in Kansas, and many others. Given uncertain market situations, especially in the international arena, what can the United States do to expand the market base for its farmers?

Active Demonstration Projects

In recent years the Special Projects Unit in the Cooperative State Research Service has been bridging the gap between research results and commercialization with demonstration projects. These projects are short term, usually 3 to 5 years, with public/private partnerships established through USDA cooperative agreements. Capitalizing on decades of public research -- generally by the Agricultural Research Service or State Agricultural Experiment Stations -- **the demonstration projects are designed to build, within the private sector, a base in which to sustain new agricultural industries. The kenaf, guayule, and hybrid striped bass projects demonstrate the success of this approach.**

Kenaf Project. Kenaf is an annual, nonwood fiber crop that grows from seedling to 10 feet in less than 5 months and can be **transformed from seedling to newsprint in less than 7 months.** It grows across the southern tier of the United States. Newsprint is normally made from wood such as northern spruce and southern pine. The United States imports about 60 percent of its newsprint supply from Canada at an annual cost of $3 to $4 billion.

The Kenaf Demonstration Project began in March 1986 with a cooperative agreement between USDA and Kenaf International - a venture capital firm and the product champion for kenaf. This agreement marked the reopening of research and development for kenaf in USDA after an 8-year hiatus. The project's principle objective was to gain acceptance for kenaf as a source fiber for the manufacture of newsprint. To accomplish this objective, a Kenaf Task Force was established involving participation of venture-capital company, private laboratories, processing and pulping plants, equipment manufactures, and the American Newspaper Publisher's Association -- a prime mover in the search for a substitute newsprint fiber.

Initial results showed that kenaf has distinct price and quality advantages. For example, it uses less ink, is stronger, results in whiter paper, and requires less energy for processing. Kenaf International and CIP Forest Products have announced plans to build a $300 million kenaf newsprint mill in South Texas for operation in 1990/91. The anticipated acreage needed to fill the mill's annual needs is 40,000 acres of unsubsidized kenaf.

And this is just the beginning. The newsprint industry estimates that it will need 19 new mills of similar size by the year 2010 to meet estimated demand. If one-half of these were kenaf mills, U.S. farmers would have a market for about 400,000 acres of kenaf.

Guayule Project. The United States is totally dependent on imported natural rubber -- a commodity of critical importance to the Nation's defense position and the economy. Approximately 750,000 metric tons are imported at an annual cost of $1 billion. Natural rubber has performance specifications not available in its synthetic alternative, and is preferred in specifications that require elasticity, resilience, tackiness, and low heat buildup. Natural rubber constitutes 30 percent of the total domestic rubber market.

Of some 2,000 plant species known to contain rubber, only a few have ever produced sufficient quantities for commercial use. The two most common sources are the rubber tree (Hevea brasiliensis) grown principally in Southeast Asia (where 90 percent of the world's supply of natural rubber originates) and guayule, (Parthenium argentatum) native to semi-arid regions of North America. In contrast to the rubber tree, guayule is a small desert shrub averaging 3 feet tall.

Under a 27-month guayule domestic rubber project signed in 1986 with USDA, the Defense Department (DoD) is providing $11 million to build and operate a prototype processing plant in Arizona that will process 275 acres of guayule shrub into 50 ton of natural rubber, 100 tons of resin and low molecular weight rubber, and 1,600 tons of plant residue. Also cooperating on this project are the Firestone Tire and Rubber Company, Gila River Indian community, and four southwestern land-grant universities -- located in Arizona, California, Texas, and New Mexico. Over this same period, USDA plans to invest about $4.5 million in guayule research and development.

With today's technology and current prices for national rubber, a domestic industry is not economically viable. An economic model indicates a farmer growing guayule would have positive cash flow in 1995, if the following technological improvements could be realized:

1) Increasing yields of rubber and byproducts 2 1/2 times, 2)Developing direct seeding capability, 3)Establishing markets for byproducts,a nd 4)Reducing production, harvesting and processing costs by one-third.

Scientists and specialists involved in this program state that these improvements can be attained by the mid 1990's with $3.0 to $4.0 million in annual R&D support.

Hybrid Striped Bass (HSB) Project. A field trial demonstration project for raising HSB in farm ponds began operation in the fall of 1986 at Walnut Point Farm near Chestertown on Maryland's Eastern Shore. HSB is a cross between the female striped bass, or rockfish, (Monroe saxatilis) and the male white bass (M. chrysops). It has the same flavor and general appearance as a striped bass but is more disease-resistant and faster growing than either of its parents.

The increasing demand and decreasing supply of fish and fish products have resulted in a dramatic jump in domestic product cost and foreign imports.

The U.S. seafood consumer now pays 64 cents of every seafood dollar to foreign suppliers. These imports amounted to over $5.0 billion in 1986, an historic record, and contribute to the Nation's balance of payments deficit. Since the harvest from our wild fisheries is not growing appreciably, the increasing consumer demand for fish can only be met by foreign suppliers or by a strong domestic aquaculture industry. Through joint ventures, U.S. aquaculture can develop to offset these escalating imports.

The market potential for HSB is promising. Because of the moratorium on striped bass fishing in the Chesapeake Bay, there is an immediate market shortfall of 14 million lbs. Private and government marketing experts estimate a beginning market of 54 million lbs. -- equal to that for trout. At that production level, producers' gross income would be about $182 million.

The margin between $1.00 - $1.50 estimated per pound costs and current New York price of $4/50 - $5.00 per pound appears adequate to attract private investment, but there are technical and market uncertainties. Will the fish overwinter in commercial size ponds. What is the best feed mixture? What regulatory approvals are needed? Who will process and market the fish? These are some of the questions to be answered by the demonstration project.

Other Potential Demonstration Projects

Several other potential opportunities for expanding the market base for farmers include expanded uses for traditional new farm crops such as **industrial oils from soybeans, meadowfoam, crambe, and winter rapeseed; absorbents, deicers, and biodegradable plastics from corn; carbon char from hardwoods; and reddrum fish and shrimp farming.**

CONCLUSION

A renewed push in commercializing promising technologies for the American farmer will not solve the immediate supply/demand imbalance. However, it represents a positive market-oriented response and a more effective long-term solution than subsidies for agricultural production in surplus.

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ECONOMIC RESEARCH SERVICE

The Role of the Economic Research Service in Technology Transfer

The Economic Research Service (ERS) technology responsibilities involve economic analysis of the potential for new technologies to affect agricultural policies, commodity production and trade, financial well-being of the farm sector and rural economies, and agricultural resource utilization. As such, the agency's technology activities are indirectly related to technology transfer.

Areas of agency technology activities include: 1) identification of technologies likely to have a significant impact on the agricultural sector and consumers including technologies directly affecting farmers, the input industry, and the processing industry, 2) analysis of the organization and effectiveness of private and public investment in agricultural research, 3) analysis of factors affecting the diffusion of new technologies, 4) assessment of the potential impacts of new technologies on international competitiveness, resource use and value, regional shifts in production, farm profitability, input demand, productivity, and farm programs, 5) assessment of the risk characteristics of new technologies and the role of the regulatory environment in fostering the development and adoption of technologies that meet acceptable risk standards while maintaining long-run competitiveness of U.S. agriculture.

Examples of Successful Technology Transfer

Because ERS is not involved in developing new technologies it cannot claim direct responsibility for successful transfer of technology. Economic viability of technology is, however, critical to successful transfer and diffusion of the technology. Three technology issues recently examined by ERS illustrate the agency's role:

- **Bovine somatotropin (bST) also referred to as bovine growth hormone (bGH) and its effects on the dairy industry.** The study analyzed national, regional, and farm-level impacts.

- **Livestock growth hormones including bGH use in dairy and beef production and porcine growth hormone use in the swine sector.** The study examined potential impacts of growth hormone adoption on feed and grain demand, land use, farm income, international competitiveness, and on food safety and product quality.

- **Cost and competitiveness of the ethanol industry and the potential for new technologies to reduce production costs.** The study examined policy tradeoffs associated with expanding the ethanol industry and the impact of future technologies.

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FEDERAL GRAIN INSPECTION SERVICE

The Federal Grain Inspection Service's role in Technology Transfer:

The primary interest in technology transfer in FGIS is that of a user of new or modified existing technologies. FGIS is presently developing systematic methods of transferring relevant technologies to the grain inspection system which, when implemented, will provide sound and objective testing procedures to facilitate the efficient marketing of grain and grain related products. The grain industry utilizes the services of FGIS and state and private inspection agencies licensed by FGIS.

FGIS has formed a task force specifically to determine the best or most efficient means of transferring the most effective technologies available to the grain inspection system. The task force identified several broad objectives to achieve the goal of technology transfer. They are as follows:

1. Introduce means to better identify end-use quality, storability, and wholesomeness criteria and establish their relevance.

2. Expand the use of objective inspection procedures.

3. Establish and maintain processes to review the relevance of inspection, sampling and weighing procedures.

4. Introduce systems that promote cost-effective, timely, uniform and reliable service.

These goals are general in nature, but are being detailed for formal implementation within the agency.

A number of grain inspection factors are traditionally determined by human senses including sight and smell. However, these subjective evaluations are increasingly pressed by public demand for accuracy and consistency despite the recognition tat the capabilities of an individual inspector are limited. On the other hand, scientific knowledge and technology are advancing rapidly. They offer both unique and unlimited opportunities for developing reliable objective grain inspection methods which can be operated at a rate that cannot be matched by human sensory means. The challenge to FGIS is therefore not only the replacement of error prone subjective methods but also the development of strategic plans and a coordinated interactive effort to identify, develop, and implement relevant end-use quality factors and objective inspection procedures within budgetary, time and staff constraints.

FGIS presently has an agreement with the Agricultural Research Service to investigate and research new technologies and assist in implementing new technologies within FGIS. Some of these technologies are subsequently transferred to the official inspection system.

A prime example of a successful technology transfer is the **Near Infrared Reflectance** instrumentation which is used by FGIS official inspection laboratories, and the grain industry. ARS developed the technology sufficiently to allow several laboratory instrument companies to further develop, refine and market the technology. As a result, a new profit making industry offers an instrument that provides quick analysis of moisture, protein, oil, and fiber without the use of classical wet chemical methods. FGIS was instrumental in the entire process. FGIS is a user of this type of equipment.

This is only the beginning. FGIS has identified many potential technological areas that are of interest to the government as well as the private sector. Quick methods for the determination of pesticide residues will undoubtedly have a major impact on the inspection system nationally and internationally. FGIS is initiating a major research initiative in the area of quick pesticide residue testing.

Image analysis is another area that is gaining more and more research dollars. The impact of this could very well extend into the private sector when and if it is completely developed and refined.

It is the desire of FGIS that technology transfer be an integral part of its mission. There is a recognized need to coordinate technology transfer processes with sister agencies within the Department of Agriculture. Coordination and a broad commitment will create the necessary change within agriculture and the associated services.

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FOOD SAFETY INSPECTION SERVICE

The Food Safety and Inspection Service, FSIS, is responsible for the safety, wholesomeness, and accurate labeling of meat and poultry products. The Agency inspects about 120 million head of livestock, 4.5 billion birds, and about 120 billion pounds of processed products annually. The Agency has a staff of approximately 8,000 inspectors in some 7,500 plants across the country. The program is technically oriented, and inspection procedures are constantly being redesigned to take advantage of new technologies, to improve efficiency, and to increase the scientific basis of inspection.

Unlike the USDA research agencies such as the Agricultural Research Service, which are technology purveyors, FSIS is a technology user. Our laboratories are dedicated primarily to the analysis of samples submitted from the field. Although we do have a very effective but modest in-house methods development effort, we are eager to make use of commercially available analytical methods and diagnostic tests to whatever extent possible. Therefore, we are usually interested in the technology transfer process from the perspective of the user.

Even as a technology user, FSIS has been engaged in technology transfer activities for the last 10 years. The Administrator of FSIS formed the Technology Assessment Division in 1980. **In 1984, the group was renamed the Technology Transfer and Assessment Staff (TTA) to reflect the staff's role in facilitating technology transfer as well as assessing emerging technologies.** The TTA Director and staff officers have expertise in a variety of disciplines, including chemistry, microbiology, veterinary medicine, and food technology. The Science Program in FSIS has also been actively involved in technology transfer.

Most of the technology transfer activities in FSIS have been in the area of rapid diagnostic tests. Efforts initiated by our Microbiology Division have resulted in the development and commercialization of useful technologies for our Agency at substantial savings.

FSIS laboratories test large numbers of samples for antibiotics and residues in animal tissues. Antibiotic testing is laborious and expensive, and most of the samples are negative. In the mid-Seventies our Microbiology Division looked for ways to eliminate the large numbers of negatives so that quantitative testing could be reserved for samples with a high probability of being positive. The Division developed a bacterial inhibition method to screen samples. The test involves inserting a cotton swab into a kidney or muscle tissue to absorb tissue fluid. The swab is placed on a media plate surface streaked with the test organism. Overnight incubation reveals growth except around swabs with tissue fluids containing antibiotics.

Trials were performed on 1,800 samples of muscle, liver, and kidney. Positive tests indicated the presence of antimicrobials but were not quantitative. Positive samples could be tested again by quantitative bioassay to confirm the presence of violative levels. Negative samples could be eliminated without further testing, meeting test objective.

Because of the test's simplicity, the idea of using it inplant soon arose. The **Swab Test for use On Premises**, or STOP, was instituted. The FSIS Program Training Division wrote a self-instruction guide for the field. The Microbiology Division planned, funded, and evaluated field trials of STOP. The test was successful, and eventually was expanded to all slaughter plants. The test kits were assembled by our procurement staff in Minneapolis in order to meet the rapidly expanding demand. Small staffs working together inhouse developed, trained, packaged, tested and implemented a useful inplant screening test that got people thinking about all kinds of inplant screening test possibilities.

A similar test was developed for the detection of sulfonamides in calves, the **Calf Antibiotic Sulfa Test (CAST)**. This time, the Agency contracted with a private firm to package the CAST kits. It soon became apparent that there was a demand for the kits outside the Agency from producers wanting to test their own animals. What started out as a quick test developed to improve our own laboratory efficiency became the nucleus of a small business. The test was commercialized. The Agency could now buy kits off the shelf for less than it cost to assemble its own kits.

The benefits to the Agency as users did not end there. The discovery of private markets did not go unnoticed. Another **entrepreneur developed a rapid and portable card test for gentamicin** at his own expense. The Microbiology Division purchased the cards and worked out protocols for Agency use. The huge up front development costs were sustained by the private firm. Descendants of the original firm still market a number of card tests for gentamicin and other analyses. This is a marvelous example of a technology transfer activity that benefited the user as well as the firm that commercialized the technology.

Directly and indirectly, these efforts produced at least a dozen tests. A lot of meat got tested that would have gone untested without inplant tests, and the advantage of working with private enterprise in test development was demonstrated.

FSIS plans to continue efforts to take advantage of available commercial technologies. Biotechnology, particularly immunology, has produced a plethora of new tests that have potential use in inspection.

FSIS is currently developing a system that will allow expeditious Agency review of proposed tests, without sacrificing scientific standards. The Director of TTA will serve as the Coordinator of the test review system. A preliminary review will establish that the test submitted is of sufficient interest to the Agency to warrant investing our resources in the full review process. Our highest priority for residue tests is for compounds with a high toxicity and a high probability of exposure in the food chain, as determined by our compound evaluation system. FSIS will not review tests that are not likely to be implemented. Our system will also help commercial test developers evaluate the potential profitability of their test.

The objective of the formal technical review is to establish that test characteristics and performance are adequate for Agency needs. We are now writing guidelines for the acceptability of tests to provide test developers with an understanding of our needs and expectations. This will be a difficult undertaking, due to the difficulty of getting a consensus among analysts in this kind of task. Also, these guidelines must not be so specific that the Agency is unable to respond in a crisis. For example, even though we want analytical methods to be able to detect analyses at the tolerance level, we would use a less sensitive method if it were the only test available. The guidelines must reflect our needs without unduly limiting our ability to respond.

Specific requirements for test approval will be linked to the intended use of the test. We will require data supporting the laboratory characterization of the test, a ruggedness test, and a laboratory or field collaborative study. The collaborative study must be performed under the conditions of intended use of the test. The applicant will be responsible for arranging, carrying out, and paying for the entire testing process. FSIS will provided review of the completed data packet.

Test approval must mean that the test, when performed by accredited analysts, with appropriate quality control and quality assurance measures, provides results that can be used as a basis for Agency decisionmaking. The decisions may range from holding a carcass for confirmatory testing to condemning large amounts of product found to be unsafe for consumption. The test review process will enhance our efforts to transfer useful technology for scientific decisionmaking to our inspection program.

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FOREST SERVICE

Mission

As the result of national debate over the management of our countries forest and rangeland resources, the Forest Service was established within the Department of Agriculture in 1905. On the same day, Secretary of Agriculture James Wilson endorsed Gifford Pinchot as the Agency's first Chief to lead and articulate a national conservation philosophy of wise use and service to the American people.

Today, the Forest Service is charged with three major areas of responsibility: administration (191 million acres of National Forest System lands), research (the largest natural resource research organization in the world), and cooperation (with State and local governments, forest industries and private landowners) to help protect and manage forest, associated rangelands and watersheds. As one of the most decentralized agencies in Federal Government, its 27,000 career employees manage 156 national forests, 83 experimental forests and ranges, 19 grasslands, and 16 land utilization projects.

Technology Transfer Program

From the relatively simple tree-planting agreements in the 1900's, FS technology transfer has evolved into a complex and broad range of programs that have influenced virtually every phase of public and private forestry. This extensive effort - conducted through state, county, and municipal governments and special compacts with individuals, corporations and academia embraces everything from **fire prevention** to a wide array of **biotechnology** and **genetic engineering**, from **utilization of forest products** and **incentive programs** for small woodland owners to **computer analysis systems** and new **organizational management techniques.**

FS technology transfer involves more than a linear relationship between research results and the user. Activities are varied and complex; some are short-lived and unilateral responses to natural disaster like **insect and disease outbreaks, floods, fires and earthquakes**. Others, like cooperation in fire management and silvicultural techniques have involved resource specialists since the beginning of the twentieth century.

The FS technology transfer program has two objectives: 1) to ensure the application of the most appropriate knowledge and technology in the management and utilization of the Nations's forests and associated rangelands and, 2) to participate in programs specifically designed to facilitate or stimulate the transfer and utilization of Federal technology to States and local governments and the private sector.

Technology transfer is something that all FS employees do as part of their jobs. Information and technology is not only transferred to cooperators but the reverse is also true; all employees constantly look for new technology and information to transfer back into the organization as well. Technology transfer is not an organization within the FS but a program responsibility that resides throughout.

In response to the **Stevenson-Wydler Technology Innovation Act (PL-96-480)** and the **Federal Technology Transfer Act (PL 99-502)** the Forest Service has centered the leadership for technology transfer with the Deputy Chief for State and Private Forestry. Operational responsibilities for execution of the program has been delegated to Regional Foresters, Station Directors and Director of the Northeast Area and the two Technology and Development Centers.

Examples of Transferred Technology

A range of techniques such as: consultation, seminars, publications, demonstrations, video, workshops, employee exchanges, formal agreements etc., form the FS technology transfer program. The more complex efforts are guided by formal technology transfer plans that identify users, the message and medium to use, actions to take and costs. Four examples are:

Timber Bridges: A 5-year plan has been prepared for the transfer of **laminated wood bridge deck technology** in response to the Federal Highway Administration identifying secondary and rural road bridge conditions as a significant problem. Over 80% of the rural bridges in 10 states are either structurally or functionally deficient. Replacement costs are estimated at $40 to $50 billion. Wood material could be used for all or part of the construction **saving 1/3 to 1/2 the expense**. Conferences have been held around the country in conjunction with road agencies and cooperators to educate engineers, designers and others on the possibilities of using wood. Many of the workshops actually have participants constructing a bridge as part of the transfer process.

Tropical Forestry: For the past 3-1/2 years, the FS has been leading a **technology transfer process for forestry organizations and personnel in the Pacific Islands of Micronesia and American Samoa**. Forests in these islands are crucial as they protect soils, shorelines, fisheries and fresh water supplies. Efforts have focused on the development of forestry personnel from over 10 different governments. Needs have been identified; and education courses developed. Personnel were exchanged with other governments; on-site seminars were held and local newsletters published. Legislation was drafted for the local communities and funding for the next generation of tropical Pacific island foresters was arranged for their education in the U.S.

Technology Transfer Agreements: Currently the Forest Service has **7 formal technology transfer agreements** with various non-Federal parties negotiated under the authorities of the Technology Transfer Act of 1986 (PL 99-502).

National Information Management Network: The Forest Service has implemented one of the most comprehensive information management networks ever created (900 computers, 18,000 terminals in over 45 states, the Virgin Islands and Puerto Rico). When purchased, the system was the largest computer contract ever awarded by Government ($120 million) and the largest distributed network ever installed. **Savings are estimated to exceed $450 million per year with a resulting 30% increase in organizational productivity. A partnership approach was formed with the vendor** (Data General) after extensive national studies that identified the organization's need for computing and electronic technology and matched it with existing technology. Standards and policy decisions for its implementation and operation were made jointly with the vendor. Pilot sites were installed to test and implementation was staged with pilot units. Line units and key supporters were identified. The effort has been successful and represents an application of technology transfer techniques within the organization.

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THE HUMAN NUTRITION INFORMATION SERVICE

The Human Nutrition Information Service (HNIS) develops and disseminates information on food and diet which aids in development of policies, programs, and educational materials by a variety of other agencies and organizations. HNIS conducts research on food consumption, dietary survey methodology, food composition, nutrition knowledge and attitudes, and dietary guidance and nutrition education techniques. Primary users of the information are nutrition and health professionals and educators in other Federal and State agencies, universities, industry and the general public. HNIS conducts an extensive program of information dissemination. Research results and nutrition education information are provided through multiple mechanisms, including technical reports, journal articles, popular publications, machine-readable data tapes, and presentations and exhibits at professional meetings. Three major areas of focus are:

National Nutrient Data Bank. HNIS collects and publishes the most comprehensive data on the nutrient composition of foods. Information on the amounts of about 60 components of the thousands of foods Americans consume is processed and stored in the National Nutrient Data Bank. **Data are developed through research and cooperation with industry, trade associations, and outside agencies. Nutrient data are used by HNIS and other Federal and State agencies, universities and industry in analysis of food consumption surveys and development of educational materials.** HNIS also cooperates internationally in the development and exchange of food composition data.

Nationwide Food Consumption Surveys. As part of the National Nutrition Monitoring System, HNIS collects and disseminates information on food and nutrient consumption of individuals and households in the U.S. for use in research, education, and food program planning. The kinds and amounts of foods actually eaten by individual household members are reported in the Nationwide Food Consumption Surveys (NFCS), conducted every 10 years, and in the smaller Continuing Survey of Food Intakes by Individuals (CSFII), conducted each year. Data from these surveys are made available to users via computer tape, agency reports, and articles in professional journals.

HNIS staff also provide consultation and advisory services to organizations and individuals in matters pertaining to household food consumption and individual dietary intakes. Special efforts are made to cooperate and coordinate with the National Health and Nutrition Examination surveys conducted by the Department of Health and Human Services.

Beginning in 1989, the **Diet-Health Knowledge Survey**, conducted as a followup to the CSFII, will measure **consumers' awareness, understanding, and attitudes about diet-health relationships and dietary guidance. The pairing of these two surveys provides a unique resource for the study of the role of diet-health knowledge and attitudes in determining food consumption behavior.** Development of the Diet-Health Knowledge Survey is a joint effort of HNIS, FSIS, and FDA.

HNIS also conducts an active program of **research to increase the efficiency, reliability, and validity of dietary surveys.** Results of these studies are summarized in a manuscript, USDA Methodological Research for Large Scale Dietary Intake Surveys, 1975-1988, which will be published in 1989.

Dietary Guidance and Nutrition Education. HNIS develops and distributes research-based information on food, nutrition and food money management, in print publications, videotape, and televised interviews. Within USDA, HNIS coordinates the review and publication of the Dietary Guidelines for Americans and develops information to help Americans put the Guidelines into practice. **Materials are directed to the general public and to nutrition and health educators.**

Recent examples include a series of Home and Garden Bulletins for consumers on using the Dietary Guidelines, a Dietary Guidelines Teaching Kit for junior and senior high school home economics teachers, a dietary guidelines poster, and a dietary analysis software package for the personal computer, designed for use by Extension home economists with their clientele.

Many HNIS information materials are used by private sector firms in developing their products. For example, HNIS nutrient data tapes are used widely by computer software companies to develop databases for a variety of dietary **analysis software packages** for professionals and consumers. Dietary Guidelines publications and popular components of these publications are used by professional organizations, health educators, and journalists, as well as Extension and other governmental agencies, in developing **new programs**, **textbooks**, and **publications** for their clientele.

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NATIONAL AGRICULTURAL LIBRARY

To many Americans, the term "technology transfer" has implied a one way flow of information: from a university laboratory to corporate engineering groups and out into the marketplace. For researchers, however, the phrase implies much more: an ongoing and multi-level exchange of information, expertise and ideas. The Japanese definition of technology transfer is congruent with that of the U.S. research community: communication of skills among individuals and groups, direct person-to-person contact.

In the past several years, a number of conferences, study commissions, published reports and new legislation have focused attention on the process of technological innovation. Several discussion points mentioned are especially pertinent to the mission and the technology transfer initiatives of the National Agricultural Library (NAL).

People: Technology is not necessarily a discrete deliverable that can be neatly packaged and forwarded. Rather, it is a continuous, complex **process of human interactions**--for ideas travel best in the minds of people.

Time: Timely access to research results is the name of the transfer game. In fact, rather than a series of sequential activities, technology needs to transfer with "real-time" mechanisms. Several studies, including one sponsored by the National Research Council, agree with this discussion by calling for a re-thinking of the technology transfer infrastructure to **optimize critical information flow from one sector to another.**

Mission

The National Agricultural Library is the repository for the collective agricultural knowledge of the world, and as such, serves as the Nation's chief agricultural information resource. The agency interacts with a national network of public and private libraries and also provides a leadership role in U.S. participation in international agricultural library and information systems.

Through its responsibilities of information management, NAL purchases and processes published and unpublished international literature and subsequently produces an electronic, bibliographic database, **AGRICOLA**, which is available through such commercial vendors as DIALOG, BRS, and Silver Platter's CD-ROM. The Library is currently testing a new method of capturing full-text, including images, in digital format for publication on CD-ROM disks. This fully integrated digital information management system offers word-searchable text as well as the possibility of electronic delivery of publications to remote sites via telecommunications networks.

The production of AGRICOLA in different formats and the research and development work with the text digitization equipment assures timely, cost effective access to agriculturally-related information from the U.S. as well as abroad.

NAL's Proactive Approach to Technology Transfer in 1988

In 1988, several thousand dollars were expended to purchase and/or process such technology transfer-related titles as: Managing the Knowledge Asset into the 21st Century, Technology Transfer Constraints Perceived by Federal Laboratory and Agency Officials, Export Controls, Expert Systems for Technology Transfer, The Leadership Challenge, Developing Critical Thinkers, Taking Charge of Manufacturing, and State Technology Programs in the United States. In addition to the acquisition of materials, Federal programs, university-based technology centers, and a variety of databases were identified to assist with the access and/or exchange of information--the transmission of critical research findings to those who have "the need to know."

Although the Library is not generally thought of in terms of conducting technology transfer or research activities, its publications and information services are very often the starting point for researchers, public interest groups, or the private sector. Examples of recently completed work include:

- A request was received from the private sector for information relative to **aseptic food packaging**. A database search revealed a number of journal articles, both U.S. and foreign, and also located the Cooperative Research Center for Aseptic Processing and Packing Studies at North Carolina State University. The requestor was given the information, including the name of the principal investigator at the research center.

- A biotechnology firm needed information on nutrition, feed formulation and worldwide markets for **cultured salmon**. The firm was investigating the potential of a bioengineered yeast pigment which could be added to salmon diets to provide the farm-grown fish with the same red flesh coloration of their wild counterparts. The wild salmon's natural diet provide the materials which give their flesh the highly preferred red color. Without a special feed additive, cultured salmon flesh has an off-white color which results in a substantially lower market price.

  After completing the research, the company marketed its product and **estimated a sales potential at between $75 million and $100 million annually**.

Water Quality Conference Established on Electronic Bulletin Board

Water quality is an issue of national significance, and it's an area that USDA has targeted as a very high priority. In 1988, NAL elected to **conduct a small water quality project,** and the challenge was to form an alliance of the thirteen different federal agencies that have responsibilities for water quality.

The mechanism currently being used for the project is a technological innovation, an electronic bulletin board with conferencing capabilities. A conference allows the caller to gain access to special interest group discussions. With the guidance of representatives from several Federal agencies, a **conference for water quality experts was established.**

As defined earlier, technology transfer is a **multi-level exchange of information, expertise and ideas.** Representatives from such organizations as the Department Operations, Research and Foreign Agriculture (House Committee on Agriculture), Office of Technology Assessment, Board on Agriculture (National Academy of Sciences), Agricultural Research Service/USDA, Extension Service/USDA, and a public interest group, the Environmental Policy Institute, are cooperating to identify water quality information for the conference members. Types of information appearing on the conference include: calendar of events, databases, innovative programming, new resources available, legislation, research, and news items.

The creative utilization of the electronic bulletin board/conference affords the opportunity for water quality experts to capitalize on the strengths of the existing research and knowledge base of their peers. It further offers the opportunity for cross-fertilization of research and ideas among the subject experts.

In addition to the those already identified as collaborators, such other Federal organizations as the Environmental Protection Agency, the Department of Interior's U.S. Geological Survey, and USDA's Soil Conservation Service have indicated interest in joining this activity. The formation of such a cooperative alliance may serve as a model of collaboration on an issue of national significance.

If successful on a trial basis, it is envisioned that other Federal agencies, university water research institutes, public interest groups, and industries will be encouraged to participate. The end result of the bulletin board/conference and its variety of users can include access to and the utilization of the nation's collective knowledge on water quality!

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OFFICE OF GOVERNMENTAL AND PUBLIC AFFAIRS
OFFICE OF INFORMATION

The Office of Information of the U.S. Department of Agriculture coordinates the transfer of new technology over the entire department. OI works through contacts with national news media and national groups and organizations. OI delegates to department agencies release of information through local groups and news media. **Information the department or its agencies deem of national importance is turned over to OI for release.**

A leader in the federal government of online dissemination of information, OI makes some department research and considerable other **information available nationally--and instantly**--online through two computerized delivery services called **"The EDI Service"** and **"USDA Online."** These two services make the current information available--within minutes of release--to literally hundreds of thousands of farmers, firms, federal and state agencies and their employees. Ten agencies of the department load data into this service.

As the department's clearinghouse for providing national release to news media of current information about the department's research and programs, OI provides the news media with press releases, news features, background statements, speeches, reports and other information. OI maintains continuous liaison with news media reporters, writers, editors, broadcasters, producers and specialized journalists. **In fiscal year 1988, OI released 1,757 of these national press materials.**

OI also delivers information to various publics through radio and television. **USDA Radio News Service contains 6-12 news items** and voice actualities Monday through Friday. These are recorded and made available daily to agricultural networks and others at 5 p.m. ET. Calls exceed 100 a day.

"Weekly Radio Services" is distributed on audio cassette to nearly 1,000 radio stations and networks. The cassette contains four weekly series -- "Consumer Time," "Agriculture USA," "News Feature Five," and "Agri-Tape/Farm Program Report." A fifth weekly service, "Hispanic Information Service," is distributed to more than 200 stations. A monthly script service, "Radio Features," is designed for use by station on-air personalities. It contains 14 to 16 consumer oriented items.

OI broadcasts three television programs by satellite each week. "Satellite TV News Service" contains eight to 12 news and feature items for use within locally produced news of farm programs. "Down to Earth" consists of five four-and-a-half minute programs aimed at producers and agri-businesses. "Agriculture Update" informs agricultural producers of ASCS activities.

From January 1 through October, 1988, the total number of calls to the "Radio News Service" was 18,582, up 643 over the same period in 1987. The number of news stories offered by the service during this period was 1,476, a 30 percent increase over the same period a year earlier. News stories with actualities in the same period in 1988 were 1,257, an increase of 307.

OI maintains a centralized file of color and black and white still **photographs, many of which illustrate various stages of research**. These are available to the public and other federal and state agencies. OI uses still photography in its slide set and filmstrip program, its publications and its exhibits programs.

The **1988 Yearbook of Agriculture, "Marketing U.S. Agriculture,"** describes the huge system that gets food from farm to table and important changes affecting the U.S. agricultural system.

The yearbook is one of thousands of publications of which OI coordinates production and distribution. In Fiscal 1988, OI oversaw the **printing of 14,036 publications**. During FY 1988, the department **distributed 7.27 million publications.**

OI coordinates various conferences to give journalists and others an opportunity to meet with department researchers and spokespeople. For example, OI has held over the past several years, a series of journalist conferences. This year they were held in Washington, D.C., and in San Francisco, in cooperation with the Food and Drug Administration, to examine a wide range of food marketing, safety and nutrition issues.

Examples of others are the "APHIS Bio-Security Campaign," for which OI produced two 10-foot exhibits and other information and "Agricultural Biotechnology and the Public," a regional conference discussing biotechnology and regulations. OI has an extensive exhibit program and among other activities is about to install an ARS international Visitors Center at Beltsville by early January 1989.

This year, OI will hold **about 1,400 audio teleconferences linking people in various parts of the country to discuss department research and programs.** For certain situations, OI transmits its press conferences live by satellite so people around the country can take immediate advantage of the information.

AGENCY TECHNOLOGY TRANSFER CONTACT:

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OFFICE OF INTERNATIONAL COOPERATION AND DEVELOPMENT

The Office of International Cooperation and Development's (OICD) cooperative programs with countries worldwide promote the transfer of new technology, knowledge, information, and skills beneficial to U.S. agriculture and other countries. All of OICD's international programs are geared toward strengthening agriculture worldwide and have one underlying theme--sharing knowledge. Work with developing countries, for example, has resulted in new information and technologies which has proven useful to U.S. small and medium-size farms, as well as with larger commercial farmers. Technology is transferred through OICD's various international programs.

OICD collaborates with other USDA and federal agencies, U.S. universities, and the private sector in conducting agricultural related international programs of long term cooperative research, short term scientific and technical exchanges and workshops; training and development; technical assistance; dissemination of information to the U.S. private sector on foreign market and investment opportunities; and liaison to international food and agriculture organizations. **These programs directly and indirectly contribute to the transfer of technologies which benefit the U.S. farmer and American agriculture as a whole, while also benefitting countries worldwide.**

As indicated in the recent 1988 Joint Council Five-Year Plan for the Food and Agricultural Sciences report to the Secretary of Agriculture, development assistance to developing countries is an investment in the future of U.S. agriculture. OICD coordinates the resources of USDA and universities who, while providing assistance to and collaborating with agriculturalists in both developing and developed countries, have identified **technologies which are adaptable to the U.S. situation.** Examples include information on **sustained-yield production systems; access to germplasm to maintain and improve the genetic base of U.S. commodities; research and development to expand international markets for U.S. food and fiber.**

Examples of Successful Transfer of Technology

Successful technology transfer activities are listed according to the following categories: international cooperative research, scientific cooperation and exchange, international technical assistance, international training, private sector relations, and international organizational affairs.

International Cooperative Research. Project scientists who have collaborated on long-term international research projects primarily disseminate their research findings through various reports and publications, presentations at workshops and meetings, and direct contact with interested users.

Cooperative research with Yugoslavia and Poland led to the **discovery of four insect parasites capable of controlling the cereal leaf beetle and significantly reducing crop damage.** The insect parasites have been released in the United States and Canada and have reduced the cereal leaf beetle problem to one of minor importance. Without these parasites, **control of this beetle by chemical means would have cost approximately $100 million in the U.S.**

Research with Egypt developed **new onion cultivars resistant to the white rot disease responsible for major losses in the U.S.** A large number of crossbred onion lines resistant to white rots were identified and the **trait for this resistance has been successfully transferred** to several commercial cultivars in widespread use in the U.S.

Collaborative research with Israel on the **control of soilborne pests by solar heating of soils,** a technique which had been used in Israeli desert regions for 15 years, **refined the procedures of solarization and initiated use of the technology in the U.S. on pistachio and vegetable crops.** The **estimated value of this technology transfer to California alone is about $31 million.**

Scientific Cooperation and Exchanges.

- Short term scientific and technical exchanges with over thirty countries involve scientists throughout the world allow U.S. scientists **access to information and germplasm** which would otherwise take years to acquire.

- To help improve overall water quality in the U.S. and around the globe, OICD coordinated an international symposium which brought together over 150 scientists from 15 countries to **formulate and apply computer models to water quality problems such as leaching, sediment yield, runoff, groundwater and surface water quality.** U.S. experts included scientists from ARS, SCS, FS, Utah State University, and the National Agricultural Chemicals Association among others.

International Technical Assistance. OICD's technical assistance programs help developing countries become more self-reliant in producing food and fiber from limited resources.

- As the economies of developing countries improve, they become better trading partners of the United States. Through technical assistance, technologies such as a **low-cost extrusion cooker** have been developed and transferred for use in manufacturing nutritious supplementary food products.

- OICD has also responded to international emergencies, by transferring technology, knowledge, information and skills to alleviate such problems as the **grasshopper/locust threat** in northern Africa, identifying and shipping effective appropriate pesticides and

USDA technicians and expertise.

- With the increasing concern in the U.S. for making better use of our agricultural resources, technical assistance to such developing countries as Kenya have resulted in valuable firsthand observation of techniques in **dryland farming.**

International Training. OICD coordinates training programs for over two thousand agriculturalists from low and middle income countries each year.

- International programs which bring agricultural managers to the U.S. for technical training help promote stronger economic and political ties between the participating countries and the U.S. Sales of commodities, goods, and services often follow the provision of training. One trainee, for example, bought veterinary supplies while in the U.S., and returned a couple of years later to purchase 500 head of dairy cattle.
- Training of trainer and other techniques developed for and used in international programs have also been found useful for application in various training and education situations in the U.S.

Private Sector Relations. Private sector relations include the organization of workshops on agricultural marketing, seminars on import requirements, and missions of U.S. agricultural industry to the Latin America and Caribbean region to explore business opportunities. PSR also involves private agribusinesses in U.S. development efforts.

International Organizational Affairs. An Associate Professional Officer Program placed USDA and other U.S. nationals in international food organizations where they receive unique technical training on global food issues important to U.S. agriculture.

REFERENCES

External Review of the United States - Israel Binational Agricultural Research and Development Fund (BARD) 1977-1988: Report of the Review Committee. November 1988

Impact Assessment of the U.S.D.A. Department of Agriculture Special Foreign Currency Research Program (1958-1980). September 1985

USDA Research and Education Committee. Annual Reports on the Food and Agricultural Sciences: From the Secretary of Agriculture to the President and the Congress of the United States.

USDA Technology Transfer Assessment and Plan. November 1986

International Programs in Agriculture, USDA, OICD

REFERENCES, cont'd.

OICD Budget Submissions and Narratives

U.S. Agriculture and International Collaboration (Draft).

AGENCY TECHNOLOGY TRANSFER CONTACT:

Calvina Allen Dupre
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SOIL CONSERVATION SERVICE

SCS's basic mission has always embodied the effective, efficient transfer of soil and water conservation technology to land users, principally through approximately 3000 field offices working in close contact with local soil and water conservation districts.

SCS also makes technology available to others through its many publications, computer programs, professional contacts with academia, other government offices, industry, trade organizations, and professional societies.

SCS has just completed an indepth study of technology management within our organization. This study highlighted **four major processes** through which technology is managed in SCS:

- Determination of the need for new resource technology;
- Development or acquisition of the needed technology;
- Transfer of technology; and
- Monitoring and evaluation of the development and transfer processes.

SCS has identified three main initiatives to improve technology transfer to the public sector:

- Providing public access to SCS-established natural resource data bases;
- Distributing SCS-developed computer software; and
- Distributing SCS training modules.

Examples of Technology Transfer

Computer Assisted Management and Planning System. Technology transfer within SCS has undergone major changes in the last few years due to availability of **microcomputers**. One current activity is the **Computer Assisted Management and Planning System (CAMPS)** concept. CAMPS uses electronic data processing techniques to combine data bases management systems with application software to assist in planning and installing soil and water conservation practices. This dynamic concept is evolving as new studies are made and more comprehensive, integrated software is developed.

Technical Documents. SCS makes numerous **technical documents** available to the public through National Technical Information Service (NTIS). Currently there are approximately 70 engineering handbooks and manuals available, ranging in cost from about $10 to $85. Additionally, some publishing houses also provide reprinted copies of SCS documents as a public service.

Computer Software. SCS also provides copies of **computer software** through NTIS. Currently there are 4 engineering and 2 economic programs available, ranging in cost from $150 to $800.

Plants Used in Erosion Control. Since 1940, SCS has developed plants useful in controlling erosion and has assisted commercial sources in making them available to the public. Through 1986, SCS's Plant Materials Centers have released about 260 new plants for commercial production.

In 1985, commercial production of SCS releases amounted to 7 million pounds of seed and 9.4 million plants. The retail value of both seed and plants was about $25 million. These plants are used for stabilization of slopes, protection against sedimentation, off-site control of sand dune migration, etc.

AGENCY TECHNOLOGY TRANSFER CONTACT:

For additional information on the Soil Conservation Services Technology Transfer Program, contact:

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APPENDIX~~E~~S

FACT SHEET ON FEDERAL TECHNOLOGY TRANSFER ACT OF 1986 (P.L. 99-502)

Signed by President 10/20/86. Amends the Stevenson-Wydler Act of 1980 (P.L. 96-480)

Key feature is authorization of Federal-Industrial Cooperative Research and Development Agreements

- With individual firms, nonprofit organizations, etc (emphasis on cooperation with small business).
- Permits the Federal research laboratory (see definition below) to "accept, retain, and use funds, personnel, services, and property from collaborating parties and provide personnel, services, and property to collaborating parties."
- Permits up front patent licensing and royalty agreements.
- 15 percent of royalties collected under such agreement (or any other patent license) goes to Federal scientists named on the patents as inventors (up to $100,000 per inventor per year).

Remainder of royalties can be used

- to pay direct expenses of administering the patent licensing program.
- to reward other scientists and support personnel contributing to the research question.
- for other activities that enhance related ongoing research.
- maximum of such royalties retained by a Federal research entity is 5 percent of its total R&D budget.

"Laboratory" is defined as "...a facility or group of facilities owned, leased, or otherwise used by a Federal agency (for) ...performance of research, development, or engineering by employees of the Federal Government."

Laboratory Directors "shall ensure that efforts to transfer technology are considered positively in laboratory job descriptions, employee promotion polices, and evaluation of the job performance of scientists and engineers in the laboratory."

Agencies are authorized "to the extent consistent with any applicable Agency requirements and standards of conduct, (to) permit employees or former employees of the laboratory to participate in efforts to commercialize inventions they made while in the service of the United States."

Federal R&D agencies must now report annually to Congress on technology transfer activities as part of their annual budget submission. This replaces the current biennial report to the Department of Commerce.

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M = member; A = alternate

FEDERAL LABORATORY CONSORTIUM FOR TECHNOLOGY TRANSFER
EST. 1974

FEDERAL LABORATORY TECHNOLOGY TRANSFER

PUTTING TECHNOLOGY TO WORK

Examples of Industry-Laboratory cooperation cotributing to our Nation's Economic Strength.

MARCH 1988

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FEDERAL LABORATORY TECHNOLOGY TRANSFER

PUTTING TECHNOLOGY TO WORK

Report prepared by:

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FOREWORD

The Nation's Federal laboratories are proving increasingly effective in contributing to our economy through technology transfer -- a term that covers a wide variety of cooperative relationships. Laboratory technologies, expertise, and mission program interests have formed the basis for many commercial innovations, some of which are described in this report.

Our message is simple: Despite the fact that the most businesslike aspects of industry-laboratory cooperation became possible only in late 198[illegible] the potential is already evident from prior successes and new initiatives. From the spin-off of small high technology companies into local incubator facilities, to long-term joint research and development with large companies, many federal laboratories and agencies are demonstrating their commitment, the workability of their cooperative mechanisms, and the wealth of commercially attractive opportunities.

This document is a collection of examples from 31 laboratories representing 7 government agencies; it should be viewed as indicative of the full potential for industry-laboratory cooperation to contribute to our nation's economic strength.

Although not addressed in this report, Federal laboratory technology transfer involves cooperation with and assistance to other important sectors of our society, such as state and local governments, universities and colleges, as well as cross-agency efforts of the Federal government.

This report was compiled and produced by the Federal Laboratory Consortium, a legislatively-chartered organization of Federal laboratories and their agencies. The Consortium works to improve and promote technology transfer by assisting businesses and others to identify the "right" federal laboratory contacts in their fields of interest, and by assisting development of the laboratories' infrastructure for cooperation.

Eugene Stark

Dr. Eugene Stark
Chairman, Federal Laboratory Consortium

EASY ACCESS TO THE FEDERAL LABORATORIES THROUGH THE FLC

You may gain access to the Federal laboratories directly through their designated technology transfer offices or through the Consortium's network. In either case the network provides a direct link to the Federal laboratories. In addition to the individual laboratory representatives, the Consortium has six Regional Coordinators and a referral clearinghouse within the Administrator's office to assist you. These contacts are listed below.

A comprehensive "Directory of Federal Laboratory & Technology Resources - A Guide to Services, Facilities and Expertise, 1988-1989" has been developed by the National Technical Information Service. The document may be obtained by calling (703) 487-4650: Order number PB88-100011, Price $36 plus $3 for handling.

The Consortium looks forward to working with you.

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FEDERAL LABORATORY CONSORTIUM FOR TECHNOLOGY TRANSFER
PUTTING TECHNOLOGY TO WORK

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FEDERAL LABORATORY TECHNOLOGY TRANSFER
PUTTING TECHNOLOGY TO WORK

BACKGROUND:

America's Federal research and development community represents a reservoir of technologies, expertise, and facilities which can be applied for the benefit of our domestic industry. This reservoir is the raw material of the age of technology, requiring cooperative refinement, application and packaging to become a powerful force for economic growth in America and for strengthening this country's competitive position in the world economy. Materials, techniques, formulas, and methods have been developed within Federal laboratories for which commercial uses have yet to be devised. Instrumentation, hardware, software, and process technologies are all part of these Federal resources.

Technology and expertise are available in virtually every area of science and engineering, including:

- Manufacturing technology
- Advanced materials
- Microelectronics
- Environmental protection
- Energy
- Building and construction
- Agriculture
- Transportation
- Ocean science
- Medicine
- Biotechnology
- Communication
- Computers
- Superconductivity

Government agencies and laboratories are striving to insure full value return for the Nation's investment in Federal research and development by offering cooperation and assistance to those who can take advantage of it for expanded use.

America's industry - businesses large and small - is in an enviable position to use this resource of knowledge and technology to enable competitive pursuit of both domestic and foreign markets. This resource can be transformed into new and improved products and services with tremendous potential for America's economy.

THE FEDERAL LABORATORY CONSORTIUM:

The need for more effective use of Federally developed technology led to the establishment in 1974 of the Federal Laboratory Consortium for Technology Transfer. The Stevenson-Wydler Technology Innovation Act of 1980 identified the Consortium as an essential component of the total technology transfer and utilization process. The Federal Technology Transfer Act of 1986 strengthened the Consortium and made it easier for American companies to work with Federal research and development organizations.

This new law encourages Federal laboratories to enter into cooperative agreements with the private sector. It gave laboratories wide flexibility regarding the use of staff, facilities, and equipment, and in intellectual property matters, to encourage increased cooperation and teamwork with private enterprise.

The Consortium is a service organization dedicated to the goal of facilitating technology transfer between the individual laboratory members and the potential users of government developed technologies. The FLC network includes nearly 400 Federal laboratories and research centers representing twelve different agencies. One strength of the network is the ability to put the potential user in contact with a Federal laboratory professional with expertise in his specific area of interest.

TECHNOLOGY TRANSFER MECHANISMS:

A wide variety of technology transfer mechanisms has proven effective. The arrangements for cooperation are made between the company and the laboratory and typically are tailored to the individual situation.

The mechanisms used in cooperating with industry may include the following:

A. Cooperative research projects in which industry and laboratory researchers work together on projects of mutual interest;

B. Workshops, seminars, and briefings put on by laboratory scientists to disseminate information on new or emerging technologies with possible applications to industry;

C. Exclusive or non-exclusive licensing;

D. Sponsored research where industry reimburses the laboratory for work done at the facility;

E. Consulting by technical and scientific laboratory personnel with unique expertise;

F. Employee exchange where researchers from the laboratory and industry trade assignments in areas of mutual interest;

G. Use of laboratory facilities where unique capabilities are present that are not commercially available;

H. Individual visits to laboratories to share information and discuss technical problems;

I. Information dissemination through publications and other printed documentation; and,

J. Membership in Industrial Affiliates organizations associated with the Federal laboratories.

The above mechanisms do not represent an all inclusive list and may also be employed in various combinations as appropriate to the needs of the particular technology being transferred.

LABORATORIES CONTRIBUTING EXAMPLES FOR REPORT:

DEPARTMENT OF AGRICULTURE:

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The above contacts represent a sampling of laboratories active in domestic technology transfer. For a more comprehensive view of the resources available, the DOC National Technical Information Service (NTIS) has published the "Directory of Federal Laboratory and Technology Resources - A Guide to Services, Facilities and Expertise 1988-1989". NTIS order number PB88-100011; phone (703) 487-4650; price $36 +$3 handling.

LISTING OF TECHNOLOGY TRANSFERS

Following are examples of successful cases of technology transfer. They are meant to illustrate the opportunities available and possible transfer methods. This is only a sample to encouragement potential users to tap the large reservoir of scientific and technical resources present in the Federal laboratories. It is hoped that the uses and benefits described will attract other potential users.

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SECTION A

COOPERATIVE RESEARCH PROJECTS

HIGH VOLTAGE CAPACITORS BECOME INDUSTRY STANDARD

THE TECHNOLOGY

LLNL Scientists working on Nova, the world's most powerful laser, are helping industry produce new generations of capacitors for storing very large amounts of electrical energy. Looming on the horizon are capacitors with energy to 50 kilojoules. Some of these capacitors will be smaller than the 25 kilojoule units available today. Livermore is aiding the industrial effort and testing many of the prototypes.

TECHNOLOGY RECIPIENTS

In the early 1980's, LLNL funded research and development programs at General Electric, NY; Maxwell Laboratories, CA and Aerovox Industries, Inc., MA to produce capacitors with greater storage capacity and lower cost. As a result, a new unit was developed. This capacitor was the same size as its predecessor but it stored four times as much energy and cost one-third as much per unit of stored energy. Now all three companies are selling 12.5 kilojoule capacitors worldwide.

Research and development teams from GE, Maxwell, Aerovox and now Westinghouse are continuing work with LLNL in order to develop a capacitor with even lower cost and higher energy density.

USES AND BENEFITS

Ten years ago, a 5 kilojoule capacitor was the largest available for pulsed power applications. Thanks to an aggressive effort by LLNL scientists, Nova resulted in 12.5 kilojoule capacitors becoming standard. The new capacitor design technology has become known worldwide as the "Nova" capacitor. It is in use today wherever there is a need to store electricity - lasers, accelerators, fusion experiments and defense research. In particular, the improved capacitors are being found in aerospace where storing the most energy for the least weight is of paramount importance. The new generation of capacitors is available exclusively from U.S. industry.

DOE - Lawrence Livermore National Laboratory

U.S. AUTO INDUSTRY USES SOLAR-CELL SPINOFF TO DEFROST WINDSHIELDS

THE TECHNOLOGY

The auto glass industry has long been looking for a thin film with the right properties to de-ice and de-fog the entire glass surface of car windows. Such a film would need to be transparent to sunlight. It would also need to conduct electricity as well as the metal wires currently embedded in auto windows. And the film would need to be easily deposited onto glass during manufacture.

In 1980, Harvard began receiving funds from the Solar Energy Research Institute to investigate a transparent thin-film coating of tin oxide containing small amounts of fluorine. The purpose of this research was to develop a thin-film layer that would act as a top electrical contact on amorphous silicon solar cells. Since this layer must permit sunlight to pass through to the cell, and then collect the generated electricity, it had to be highly transparent and a good electrical conductor--the same characteristics required by the auto glass industry.

TECHNOLOGY RECIPIENTS

After eight years and a research cost of about $500,000, the Harvard project has yielded a transparent conducting oxide (TCO) and a fabrication process that is now being used to annually produce more than 1 million sq. ft. of coated glass for solar cells and modules.

The tin oxide film also has solved the de-icing problem for auto manufacturers. Utilizing similar technology, major glass manufacturers have adapted TCO coatings to their commercial products. For example, the Ford Glass Division is now making "Insta-Clear" windshields available on Ford Taurus, Mercury Grand Marquis, and Lincoln Continental, and other car models. This windshield completely defrosts a 1/10-inch coating of ice in two minutes even at the low temperature of zero degrees Fahrenheit.

USES AND BENEFITS

Projections indicate that a decade from now, 100 million sq. ft. of TCO glass could be used in automobiles, and about the same amount could be covering amorphous silicon photovoltaic modules.

DOE - Solar Energy Research Institute

COPPER INDIUM DISELENIDE PROMISES CHEAPER SOLAR CELLS

THE TECHNOLOGY

Photovoltaic (solar) cells produce electricity directly from sunlight. To many, such a technology promises to brighten America's energy picture as well as improve our international competitiveness and balance of trade. But before it can move into a larger market, this clean and inexhaustible source of energy awaits reduced cost and increased reliability.

These goals may soon be achievable with copper indium diselenide, a thin-film semiconductor material that absorbs sunlight very efficiently. A layer just one micron (0.00004 inches) thick can produce large amounts of current. The material is also available to large-area, continuous processing techniques. And solar cells made with copper indium diselenide are extremely stable.

TECHNOLOGY RECIPIENTS

Copper indium diselenide is coming into prominence through research performed by Boeing under a subcontract to the Solar Energy Research Institute. Boeing researchers determined the materials needed to make a complete and stable solar cell from copper indium diselenide, as well as the ratio of the material constituents, the optimum thickness of cell layers, and the proper impurities required to enhance photovoltaic characteristics. Boeing also devised a co-evaporation method to make the cell. The method and its product were honored in 1985 by Industrial Research magazine as one of the 100 most significant technical achievements of the year. Boeing is now refining its method to make efficient, large-area submodules.

Recognizing the significance of this effort, ARCO Solar--the world's largest manufacturer of photovoltaic cells--reproduced the work. ARCO then branched out into its own innovative developments and has since become the global leader in copper indium diselenide.

USES AND BENEFITS

This recently developed material is already finding uses in small power generation and consumer commodities. Once further refinements are made, both ARCO Solar and Boeing expect to tap the large international market of remote power generation and domestic utilities.

DOE - Solar Energy Research Institute

GLASS/CERAMICS: KEY TO ADVANCING COMMERCIAL GLASS-TO-METAL SEAL TECHNOLOGY

THE TECHNOLOGY

Monsanto Research Corporation-Mound scientists and engineers are continuing to advance the state of glass-to-metal seal technology. MRC-Mound has established the manufacturing processes, compositions and processing techniques for making high-strength glass/ceramic seals to high-strength superalloys. The glass/ceramic thermal coefficient of expansion is controlled so that it matches that of the superalloy to which it is joined. Currently, these special glass/ceramics (S-glass) components are manufactured only at MRC-Mound for use in nuclear weapons. S-glass technology was initially developed at Sandia National Laboratories Albuquerque (SNLA) and has been made available to private industry on a licensing basis.

Since it is of great benefit to the Department of Energy (DOE) to have several qualified commercial suppliers of critical weapons components, a program was begun in 1986 to systematically transfer MRC-Mound's expertise in this production technology to industry.

TECHNOLOGY RECIPIENTS

MRC-Mound began the process of S-glass technology transfer in May 1986, and the final selection of qualified vendors will be completed early in 1988. The process began with an invitation to 28 companies to participate in the technology transfer process. The invitation provided information about the types of products, criteria for selection and drawings of typical products. Eight of these companies expressed interest and met the selection criteria, and they were invited to send representatives to Mound for a one-day seminar which included presentations of equipment and processes in manufacturing use (with tours of appropriate areas); quality assurance requirements and methodology and business policies and procurement procedures required at Mound. Response to this seminar was excellent.

The supplier qualification process continued with site visits by Mound technologists to all participants' facilities; drawings and specifications were furnished and direct interface was provided to their technical personnel to answer questions and review plans. Mound then provided to each participant 100 sets of piece parts (shells, pins and glass preforms) for fabrication of a prove-in lot. Finished parts were inspected at Mound using the same procedures as for Mound production. Successful completion of this phase would result in the company being placed in an approved vendor list. Five companies have successfully reached this category.

USES AND BENEFITS

High-strength glass/ceramics sealed to high-strength superalloys and stainless steel have many uses in electronics, for very large optical telescopes, in substrates for microchips and possibly even in cookware. The glass/ceramic works like a glass, not a ceramic with much simpler processing (6 steps versus 30 in one manufacturing operation). The bottom line: It is more cost-effective, a higher strength product for less money.

DOE - Monsanto Research Corporation - MOUND

ECCAD - STATE OF THE ART ELECTRICAL CIRCUIT CHARACTERIZATION

THE TECHNOLOGY

INEL scientists developed the Electrical Circuit Characterization and Diagnostic (ECCAD) System for the Three Mile Island (TMI) clean up program. TMI needed a system to remotely assess quality of circuits so as to minimize exposure of personnel to radioactivity. ECCAD is an automated state-of-the-art system that remotely measures basic circuit parameters in a large, complex industrial plant. Although it was developed for a specific use at TMI, it has very broad applications within the nuclear and non-nuclear power industry. ECCAD characterizes electrical circuits and diagnoses the effects on environment and aging of electrical circuits. Such effects include the total environmental impact on a circuit, not simply those caused by radiation or temperature. In addition, historical information collected using ECCAD can provide data that could be used to increase the time a circuit is allowed to stay in service before preventative maintenance is required.

TECHNOLOGY RECIPIENTS

This technology was transferred to Pentek, Inc., Corapolis, PA and is now the basis for a new subsidiary, ECAD Services, Inc., Middletown, PA. ECAD Services, Inc. is now providing commercially available systems and services to assist power plants in the application of this technology to verify the operational condition of electrical circuits and to quickly locate failed areas. The company recently announced the first sale of their System 1000 Digital Diagnostic System for power and control circuits to Souther California Edison for use at the San Onofre Nuclear Generating Station in San Clemente, CA.

Early in the stage of the transfer of the ECCAD system, the INEL Project Manager accepted a position with Pentek and assisted in completion of the transfer and introduction of their new subsidiary. In addition, Pentek was provided copies of all existing information on the technology, including unpublished data, copies of engineering drawings and user manuals.

USES AND BENEFITS

Until now, high quality circuit characterization measurements could only be conducted in a laboratory environment under strictly controlled conditions. With Pentek's ECAD system, these measurements are made using rugged, commercially available instruments and microprocessor-based computing equipment. It is easily operated by a single technician, and the equipment is completely self-contained in a portable rack/cabinet assembly mounted on casters for easy movement and operation.

The ECAD System 1000 is available as a complete unit from Pentek, Inc., Pittsburgh, PA. In addition, the original ECCAD system technology as developed at the INEL is not patented and is therefore available for transfer to industry.

DOE - Idaho National Engineering Laboratory

AMES LABORATORY TECHNOLOGY IS THE BASIS FOR A NEW START-UP COMPANY

THE TECHNOLOGY

A new photoacoustic cell (PAC) for use in Fourier Transfer Infrared (FTIR) spectrometry has been developed at DOE's Ames Laboratory. The PAC facilitates the application of FTIR spectrometry to the rapid, nondestructive analysis of small samples of complex organic mixtures, e.g., coal, textiles, semiconductors, pharmaceuticals, environmental pollutants, etc. with little or no sample preparation.

TECHNOLOGY RECIPIENTS

The PAC technology has been transferred from Ames to the private sector via a new start-up company whose proprietor is the scientist responsible for the cell's development. That company, MTEC Photoacoustics, Inc., is currently supplying the cells as FITR accessories to major instrumentation manufacturers including IBM, Digilab, Perkin-Elmer, Nicolet, Matteson, and others. In addition, the cells are sold directly to FTIR users. Exports to Canada, Europe and Japan constitute over half of the Company's volume.

USES AND BENEFITS

The new photoacoustic cells are used throughout the analytical community for samples composed of mixtures of organic and inorganic components which differ widely in their optical properties, for powder samples, and for small samples or those which may not be altered or destroyed (such as artifacts or treasures). Benefits of this technology include speed of analysis (over 20 times faster than previous similar technology), minimal sample preparation, nondestructive nature, and wide range of applicability.

The creation of a new business to perfect and market the technology has resulted in a positive and growing impact on economic development. In addition to the direct benefit to the new entity, the commercial activity resulting from this technology transfer provides a considerable increase in business for a local machine shop, increased sales for component suppliers, and the enhancement of the product lines and volumes of the larger instrument manufacturers involved.

DOE - Ames Laboratory

TERFENOL-D TECHNOLOGY TRANSFERRED USING AN INNOVATIVE MECHANISM

THE TECHNOLOGY

A new giant magnetostrictive material, Terfenol-D, has been developed by the Ames Laboratory-USDOE and the Naval Surface Weapons Center. Preparation and processing techniques which yield the terbium-dysprosium-iron alloy in useful shapes with maximum performance characteristics were perfected at Ames.

TECHNOLOGY RECIPIENTS

These materials and processing technologies have been transferred to Edge Technologies, Inc., a new for-profit corporation created to effect the commercialization of promising results from Ames Laboratory and Iowa State University research projects. Edge has established its first division, the ETREMA Division, to produce and market Terfenol-D and related materials. Edge and the ETREMA Division will also actively participate in the extensive product and device development efforts which will be required to properly exploit the technology.

USES AND BENEFITS

Terfenol-D will be applied in the fields of SONAR, robotics, valving, vibration dampening, micropositioning, electrical machinery and switch gear, pumps and hydraulics, sound reproduction and others. The Ames Laboratory has worked with numerous companies in these fields, through individual joint projects and formal workshops, to introduce the technology and to assist in the necessary research and development. Examples of these industrial interactions include those with Gould, Raytheon, Westinghouse, United Technologies and Fisher Controls. Ames continues to maintain a close and productive interaction with Edge Technologies, Inc. as that company implements the development and marketing of the technology, both in the U.S. and throughout the world.

Extensive benefits have been realized and great potential benefits have been identified through this case. The material is a much more efficient and powerful medium for the conversion of magnetic energy to mechanical motion than the alternative choices, e.g., piezoelectric ceramics or nickel.

Other benefits will be generated by the mechanism and organization which have been developed in this activity. Edge Technologies, Inc. will pursue corporate objectives which include the creation of new businesses, economic diversification, and assistance in the development of other technologies. It represents a unique and effective cooperative enterprise involving a federal laboratory, a major research university and the private sector.

DOE - Ames Laboratory

SAVING STEEL DOLLARS: ULTRASONIC FLAW DETECTOR FOR HOT STEEL

THE TECHNOLOGY

Each year millions of dollars worth of good steel is discarded in a conservative effort to assure the quality of the steel Now a device has been developed that could save steel manufacturers more than a million dollars a year per mill.

Steel is produced by rolling hot slabs of the metal before it is formed into shapes. The ends of the rolled slabs contain imperfections that must be sheared off before the metal can be used. At present, the only way to detect these imperfections without cooling the steel is visual--an imprecise method for knowing how much of the steel is flawed. To be on the safe side, manufacturers discard some good steel along with the flawed to make sure the remaining steel is sound.

In a 2-year collaborative effort, a trade association (the American Iron and Steel Institute), together with two national laboratories (the National Bureau of Standards and Argonne National Laboratory) and a private company (Magnaflux Corporation), has developed a device that uses ultrasonic waves that are coupled to the inside rim of a 3-foot-diameter wheel. As the wheel rolls over the hot steel slab, the sound waves are transmitted through the rim into the hot metal. Where imperfections occur, the sound waves are reflected. These reflections are fed into a small computer that generates color maps of the internal structure of the slab, showing the shape, size, and location of the imperfections. Since no cooling is required for this method of nondestructive evaluation, energy also is saved.

Early cooperative effort was required to bring the ultrasonic high-temperature flaw detection system to the stage where it could be used in-line in a steel mill. This is a good example of the significant benefits to industry that can result from cooperative interaction between the government and private sectors.

TECHNOLOGY RECIPIENTS

At the time of writing (early 1988), a Magnaflux-built system has been delivered to an AISI member mill and is being "debugged."

USES AND BENEFITS

The device can be used in-line within a steel mill to clearly define imperfections in hot steel. The American Iron and Steel Institute (AISI) has estimated that a single steel mill could easily save more than $1 million per year with the new device through the increase in production of usable steel. The savings that would result from widespread use in steel rolling and continuous casting processes could go far toward strengthening the U.S. position in the steel marketplace.

DOC - National Bureau of Standards
DOE - Argonne National Laboratory

POWDER IMPROVES FATIGUE LIFE

THE TECHNOLOGY

The use of powder Metal (PM) components is generally felt to be limited in at least two ways, viz., in size and in fatigue resistance. Hot Isostatic Pressing (HIP) has promise in both areas. Through a series of cooperative programs between Benet Laboratories and Crucible Steel Co., technology to produce heavy (200 pound) steel PM parts with high strength (170Ksi YS) and toughness and fatigue life comparable to those attained in close die forgings, was developed. The important parameters are reduced gas content in the powders, the prevention of oxidation on the surfaces of the steel powders and the proper use of HIP. The ability to achieve outstanding properties, with an additional benefit accruing from the near Net Shape capability open a new field for Powder Metallurgy.

TECHNOLOGY RECIPIENTS

As a major participant in the several programs, Crucible Steel Co. expanded their capabilities and have potential for producing large, heavy steel parts, economically and with hitherto unachievable properties. The potential for this technology has been presented internationally at several conferences and in a series of lectures at Battelle Columbus and Ohio State University, as well as being presented in reports and articles, all of which have elicited favorable comments and requests for details.

USES AND BENEFITS

This technology has extended the areas for potential use of powder metallurgy to steel parts weighing up to several hundred pounds, and requiring high strength, high toughness and high fatigue resistance. With the control of gas content in, and oxidation on, the powder particles, inclusion content is virtually eliminated. Equally important is the elimination of flow lines associated with forging, and causing anistropic mechanical properties.

DOD - Army Benet Laboratory

AIRCRAFT DE-ICING DETECTION TECHNOLOGY

THE TECHNOLOGY

Federal Aviation Administration Technical Center (FAATC) personnel, in conjunction with researchers at the Massachusetts Institute of Technology (MIT) and the National Aeronautics and Space Administration (NASA) have contributed to advancing the state-of-the-art in aircraft icing detection equipment. This was achieved through the development of a highly accurate ultrasonic ice detection system. Previous ice detection systems employed probes which accreted ice differently than the aircraft wing and control surfaces, leading to false measurements. Commonly used capacitive type sensors have difficulty providing consistent thickness figures under glaze and rime ice conditions. The ultrasonic icing detector suffers from none of these deficiencies, being flush mounted to the wing and control surfaces, as well as providing consistent rime and glaze ice measurements. The principle employed is similar to that employed in sonar and the auto focus camera. Basically, an acoustic wave is generated which propagates through the ice and is reflected at the air/ice boundary. Relatively rugged and simple electronics measures the transit time of this wave and converts the elapsed time to the ice thickness. This thickness is then transmitted over signal wires to the cockpit for display to the flight crew.

TECHNOLOGY RECIPIENTS

The development of the ultrasonic ice detector is a prime example of a successful technology transfer activity. Working with the support of the FAATC and NASA Joint University Program, the initial idea was conceived at MIT and refined with the help of the FAATC Icing Program personnel, who also assisted in testing the device at NASA's Lewis Research Center Icing Conditions Wind Tunnel. The more mature brass board model Ultrasonic Icing Detector was then successfully flight tested in NASA's Twin Otter research aircraft. This joint cooperative arrangement led to all three agencies sharing the fruits of the research. Furthermore, the transfer of the technology did not end there, but rather, the Ultrasonic Icing Detector was patented, and the technology made available to the industrial sector. Simmonds Precision, a subsidiary of Hercules Incorporated, subsequently obtained a license for the technology, and is in the process of commercializing the system. The Boeing Company, of Seattle, Washington is the first corporation to utilize this system in private sector aircraft operations, having recently flight tested it in the Boeing 757 test aircraft. During these flight trials, significantly higher ice accretion was detected in the engine inlets than that estimated by the flight crew. As a result of these trials, the Ultrasonic Ice Detection System is currently under consideration for incorporation into the next generation 707 Boeing jetliner.

USES AND BENEFITS

In several recent air carrier crashes, icing has been implicated as a major contributing factor. Timely information on the state of aircraft icing by the flight crew would have enabled corrective action to be taken, which would have forestalled tragedy. The Ultrasonic Icing Detector also is employed in aircraft flight test and wind tunnel testing to study the process of ice formation and potential remedies to that condition.

DOT - Federal Aviation Administration (FAA) Technical Center

CLEAN COAL DEMONSTRATION PROJECTS TO COMMERCIALIZE NEW PROCESSES

THE TECHNOLOGY

Technologies that use coal more cheaply, cleanly, and efficiently are moving forward through the Clean Coal Technology demonstration projects. These technologies have been developed under long-term projects with Federal funding to the private sector and through in-house research. Clean coal processes have taken a serious, important step toward commercial use.

Pressurized fluidized-bed combustion (PFBC), underground coal gasification (UCG), and integrated gasification, combined cycle (IGCC) power generation with hot gas cleanup will be demonstrated through projects with American Electric Power Company (AEP), Energy International, Inc. (EI), and the M.W. Kellogg Company (Kellogg), respectively.

These technologies have been nurtured through the funding and the research participation of the Morgantown Energy Technology Center (METC), along with contributions from other laboratories. All three clean-coal projects are cost-shared, with the Government share averaging less than 50 percent.

TECHNOLOGY RECIPIENTS

Given the high percentage of industry's cost-share in these projects, it is obvious that the private sector expects these technologies to be commercially viable. The technologies have thus passed the long-term, high-risk stage of research and are ready for demonstration.

USES AND BENEFITS

PFBC and IGCC systems can be used for new facilities or for repowering existing facilities. Coal-fired power plants can be retrofitted to reduce emissions while increasing plant capacity and extending plant life. Both these systems can be built in modular increments and can be used in utility and industrial power generation. Advantages include lower investment risk and the use of shortened and less expensive fabrication methods. Both systems can burn many various types of coal, including high sulfur coal, in an efficient and environmentally acceptable manner.

Applications of the proposed UCG project include agricultural fertilizer, refinery distillate feedstock, and substitute natural gas. Seventy-five tons per day of ammonia and 500 tons per day of urea fertilizer will be produced. It is anticipated that the cost of synthesis gas produced using UCG will be lower in cost than synthesis gas produced from natural gas purchased on the open market.

All three demonstration projects promote the use of this country's largest fossil fuel energy source -- coal.

DOE - Morgantown Energy Technology Center

COMSAT TECHNOLOGY SAVES UHF-TV INDUSTRY DOLLARS

THE TECHNOLOGY

Much of the R&D work in electronics components for communications satellites is directed to making them as efficient as possible, to make best use of the limited power supplies on these satellites. One such component is the multistage depressed plate collector (MDC), developed in the 1970's by Lewis Research Center's Dr. Henry Kosmahl. The MDC amplifier allows communications satellites to transmit more powerful signals, which in turn simplifies ground stations. One Earthbound electronic component the MDC can be fitted to is the klystron, the frequency generator tube used in UHF-TV transmitters. The MDC can double the efficiency of the klystron tube, recycling electrons normally lost as waste heat.

TECHNOLOGY RECIPIENTS

Lewis Research Center scientists have worked with Varian Associates of Palo Alto, CA, the National Association of Broadcasters, and Public Broadcasting Systems to develop an MDC klystron tube. Varian is the largest producer of UHF klystrons in the U.S.A. and Canada. The Applications Project lasted three years and resulted in the building and testing of a prototype MDC klystron. Varian expects to put it into commercial production in 1988.

USES AND BENEFITS

The UHF-TV industry will be the principal beneficiary of the MDC klystron project. UHF transmitters require greater power than VHF for comparable reception, and operate at lower efficiencies. The MDC klystron operates at twice the efficiency of the standard klystron and will cut the power consumption of a UHF-TV station by one half. For a typical 200,000 watt UHF-TV station, this savings could be $150,000 a year. This could be a critical savings for public TV stations that rely upon foundation grants and public donations for their operating revenues.

NASA - Lewis Research Center

FACTORY OF THE FUTURE PROVIDES TEST-BED FOR INDUSTRY

THE TECHNOLOGY

Factory automation gives promise of increased productivity, accuracy, flexibility, and speed of production. The NBS Automated Manufacturing Research Facility was conceived of and built to demonstrate that computers, robots, carts and digitally controlled machine tools from a wide variety of U.S. manufacturers could be made to work harmoniously in a single system. The system extended from design of parts with computer assistance to manufacture and testing of those parts. Further, the ability to introduce the system, piece by piece, into existing machine shops was considered both desirable and practical. The system was built and demonstrated with the active participation of people from industry, academia and government with major funding support from the Navy. It has been completed and is now operating as a test bed for evolving computer and equipment developments.

Industry participated from the start, with more than 50 research associates from about three dozen companies active in different parts of the program. More than $5.7 million of equipment has been donated or loaned to the AMRF.

At least 10 voluntary industry standards have been adopted or are under consideration due in part to support by the AMRF. Sixteen patents have been issued, and several have been licensed to industrial firms as a result of the AMRF. At least 20 commercial adaptations of AMRF research in new products and systems are offered by U.S. firms.

Numerous tours and open-houses bring large numbers of industrial visitors to the facility. NBS is currently working closely with the consortia of companies and other government agencies in implementing this technology in production facilities.

TECHNOLOGY RECIPIENTS

The Navy in adapting the new technology to production of part through the South Carolina Research Authority and at the Mare Island Naval Shipyard in California. Each of the companies sponsoring research associates, manufacturing components invented at the AMRF or manufacturing to meet the new industry standards feels the impact of this program.

USES AND BENEFITS

Each participating company brings expertise to the AMRF and supplies detailed understanding of existing and improved components and systems. The hundreds of visitors and those who read articles or see videos of the system obtain information leading to improved U.S. industrial capability. The proof of concept system encourages companies to plan for their own automated facilities.

DOC - National Bureau of Standards

CONSORTIUM BRINGS AGREEMENT ON CO_2 MEASUREMENTS

THE TECHNOLOGY

To determine the quantity of pipeline CO_2 delivered to the oil extraction industry in huge amounts, both measurements and calculations are required. Fourteen energy firms involved in supplying and in using this gas formed a consortium in 1983 under NBS leadership to come to agreement on the mathematical models appropriate to these measurements. A preliminary computer code was delivered within 12 months and that code in its updated form is used by the 14 consortium members and others to measure the millions of dollars a day flow of CO_2 to major oil fields.

The story has a sequel of even greater value to industry. Other complex computer codes developed with support from a follow-on Consortium on Supercritical Fluids, guide industry in the use of supercritical fluids for the separation and purification of chemicals. Fluids at particular elevated temperatures and pressures are used to extract or remove wanted or unwanted products from a chemical process stream such as removing caffeine from coffee and tea, extracting lemon oil from lemons and asphalt from petroleum residues.

TECHNOLOGY RECIPIENTS

Consortium members include: Cooper Energy, Allied Chemical, Texaco, Gas Processors Association, Monsanto, Amoco, DuPont, Mobil, Shell, Sohio, ARCO, Ingersoll Rand, Air Products, Phillips Petroleum and the Department of Energy. Other industries used the published reports to move forward with these new technologies.

USES AND BENEFITS

CO_2 valued at millions of dollars per day is now measured with improved reliability. Whole new product processing technologies using supercritical solvents have been opened up to the chemical processing industry.

DOC - National Bureau of Standards

NEUTRONS USED TO MEASURE MICROMETER THICK SURFACE LAYERS

THE TECHNOLOGY

Very thin surface of helium, lithium, boron, nitrogen and chlorine are an integral part of the materials used in the fabrication of microcircuits. A new technology using neutrons from the NBS research reactor has been developed to measure nondestructively the depth profile of each of these elements with a depth resolution of about 10 nanometers. Users from industry bring samples to NBS where measurements are made around the clock, seven days a week often with a two month backlog. The neutrons activate a minute fraction of the atoms under study that in turn emit radiation that is measured outside of the sample. Each element produces detected radiation characteristics of that element, but modified in energy as it passes through the material proportional to the depth of origin.

Formal research associate agreements exist with AT&T Laboratories and Intel Corporation. Industrial guest researchers who have been or are using the facility come from Eastman Kodak Research Labs, GTE Labs, Motorola, General Electric, Aluminum Corporation of America, Bell Northern Research, and the Aerospace Corporation. The American Nuclear Society held a session on the industrial applications of Neutron Depth Profiling chaired by NBS.

TECHNOLOGY RECIPIENTS

The above listed research associate agreements and list of industrial guest workers indicates the intense research interest in the neutron depth profiling, (NDP), technique. Often the industrial research is conducted in collaboration with university students and professors.

USES AND BENEFITS

Because of the importance of the elements determined by NDP in the electronics industry the technique is used for R&D in emerging technologies. NDP is frequently used as a reference technique to independently verify the reliability of the measurements of other techniques and to produce reference materials in day to day on site use. In some areas of semiconductor manufacturing NDP is the only reliable way to establish quality control in a product or processing step. NDP has been responsible for saving industry hundreds of thousands of actual dollars as well as in man-hours.

DOC - National Bureau of Standards

HIGH TEMPERATURE SUPERCONDUCTIVITY DEVICE DEVELOPMENTS

THE TECHNOLOGY

With the widely heralded discovery that certain ceramic materials exhibit superconductivity at temperatures far higher than earlier metallic superconductors, NBS has taken the lead in applications to working devices. In May 1987 the first practical device made of the new superconductors operated at temperatures above the temperature of liquid nitrogen. The Superconducting Quantum Interference Device or SQUID measures tiny changes in magnetic fields. SQUIDs operating at low temperatures have already been employed to measure brain waves, associated with tiny currents in the head and signals from other electrical activity in the body. Since the SQUID itself is very tiny, in principle an array of these devices placed outside the head could map the flow of currents in the brain.

A second breakthrough technology was developed by NBS scientists in collaboration with the Westinghouse Research and Development Center in Pittsburgh, Pennsylvania. New low resistance contacts were devised making it possible to join superconductor circuits without creating a hot spot where the current flows through a higher resistance connector. Previous connections had been a barrier to measurements of superconducting devices and to their applications. The new contacts have a resistance 1000 to 100,000 times lower than the indium solder, silver paint or silver epoxy contacts they replace.

Details of the process for producing the new contacts were published in Applied Physics Letters, and in the technical press, with reprints made widely available.

TECHNOLOGY RECIPIENTS

This technology was first available to the collaborating partners, but as the new field is developing rapidly, it was published for all who would develop circuits to be operated at the new higher temperature superconductivity levels.

USES AND BENEFITS

All circuits that join one superconducting component to another will use this new technology. As the superconducting circuit industry is in its infancy, it is too early to estimate the savings this will provide.

DOC - National Bureau of Standards

ADVANCED STUDY PROGRAM IN HIGH-TEMPERATURE SUPERCONDUCTIVITY THEORY

THE TECHNOLOGY

Superconductivity research efforts, have taken the place a Los Alamos National Laboratory with the support of the Department of Energy for several years. The search to produce High-Temperature Superconductor (HTS) materials has been the subject of several investigations ever since superconductivity was first observed, and in mid-1987, HTS research efforts at Los Alamos reached significant levels.

Application of superconductivity is varied in scope from fusion reactors and high-energy particle accelerators to propulsion systems. However, the most exciting application of superconductivity may yet lie in the domain of electrical power generation and distribution. This application of superconductivity has triggered a unique type of technology transfer effort between Los Alamos National Laboratory and the electrical utility industry.

TECHNOLOGY RECIPIENTS

A collaborative effort between Los Alamos National Laboratory and an electrical utility, the Public Service Company of New Mexico, began in 1987 to explore industrial applications of HTS research. This collaborative arrangement involved the use of the Public Service Company of New Mexico's first Senior Scientist Fellow, Dr. Robert Schrieffer, a 1972 Nobel Laureate, and is viewed as a novel method of technology transfer at Los Alamos National Laboratory. The intent of this research effort is to expedite the transfer of HTS research results conducted from Los Alamos to the electrical generation and distribution industry. Under the auspices of the arrangement, Public Service Company of New Mexico has established a $570,000 program at Los Alamos National Laboratory which will allow Dr. Schrieffer to work exclusively on HTS experimental projects for a two month period each year of the two year project. This program will also include other well known university researchers.

USES AND BENEFITS

As an industrial entity, Public Service Company of New Mexico stands to gain immensely from its collaborative arrangement with Los Alamos National Laboratory. The major benefit gained by the corporation is that it receives a continuous stream of information and technology related to the prospects for HTS commercialization. The corporation could potentially benefit its ratepayers and stockholders in the long run through its sponsorship of research efforts leading to potentially more cost-effective methods of electrical generation and distribution. The benefit to Los Alamos National Laboratory will be the availability of Dr. Schrieffer to the Laboratory during this project, lending his expertise in theoretical physics to HTS experimental projects and thus strengthening the Laboratory's overall program in this important area.

DOE - Los Alamos National Laboratory

FLOW CYTOMETRY INSTRUMENTATION: FUTURE MARKET CHANGES

THE TECHNOLOGY

Many members of the Los Alamos National Laboratory Life Sciences Division have contributed to flow cytometry research work in conjunction with other world-wide research organizations. Flow cytometry research involves the examination and sorting of cells. The cells flow single file through a narrow passageway of a flow cytometer at an average rate of 3000 cells per second, where a laser beam or other light source illuminates each cell.

This technique of cell examination and sorting allows researchers to measure cell properties such as cell size, DNA content, presence of specific antibodies, permeability of cell membranes to certain molecules, and other cell characteristics. The instrumentation of flow cytometry allows for these measurements to be made with great precision and high statistical accuracy. One of the premier uses of this technology is it's application in cancer research efforts, as well as cancer diagnosis and treatment.

TECHNOLOGY RECIPIENTS

The original research work done on flow cytometry began at Los Alamos National Laboratory in the 1960's and was supported by the Assistant Secretary for Environment of the Department of Energy and by the National Cancer Institute. Improvements in cell staining and measurement techniques led to the commercialization of flow cytometers in the mid 1970's. Coulter Electronics, founded by former Los Alamos staff, was one of the industrial pioneers to manufacture flow cytometers. In recognition of the assistance received from Los Alamos regarding this technology transfer effort, Coulter Electronics donated its 100th commercial unit to the Laboratory in May, 1983.

USES AND BENEFITS

The continued and stable trend in manufacturing of flow cytometer instrumentation is a strong indication of the state of technology related to flow cytometry. According to an industry spokesman, the current world market of flow cytometers, including reagents, is estimated to be $60 million annually. Of this figure, approximately 75% of annual market sales can be attributed to the sale of flow cytometer instrumentation. The spokesman also indicated that the market for flow cytometers is currently in transition. Once dominated by the research-user market, the new market horizon lies in addressing hospital and clinical user needs. the average market price of a flow cytometer for use by researchers is between $150,000 and $300,000. The industry spokesman estimates that the smaller, more compact flow cytometer developed for hospitals and clinical use will run $75,000 to $80,000 per unit. With the increase of flow cytometer use by the hospital and clinical user, the outlook for the flow cytometer instrumentation industry looks very promising.

DOE - Los Alamos National Laboratory

LASER ANGIOPLASTY-BIOMEDICAL COMPANY WITH PRODUCT DEVELOPMENT PROBLEMS

THE TECHNOLOGY

Laser angioplasty procedures have been used as a safe, effective method of unclogging femural arteries in clinical test situations since 1986. This medical breakthrough was supported by research efforts conducted by the Materials Sciences Division and Chemistry and Laser Sciences Division of Los Alamos National Laboratory. A request for novel solutions to problems encountered by BV Medical, Inc., a biomedical company from Minneapolis, Minnesota, led to the laser angioplasty research effort at Los Alamos.

THE TECHNOLOGY RECIPIENTS

In order to explore new solutions to the problems faced by BV Medical in the development of laser angioplasty products, a full-cost recovery research contract agreement between the Department of Energy and BV Medical was formed to support the work at Los Alamos National Laboratory. This agreement led to technically challenging work and a novel solution to the company's problems regarding product development. Under the agreement, BV Medical was able to appreciate first-hand the value of technical expertise at Los Alamos National Laboratory, and at the same time become aware of additional technology available at Los Alamos which had industrial applications.

Through an additional agreement, which creatively met the needs of BV Medical, Los Alamos National Laboratory was able to meet further needs of the company in a faster, more cost-effective way than would have been possible under a traditional contracting agreements. This creative agreement allowed a Los Alamos National Laboratory staff member to go on a 20% part-time status at the Laboratory in order to form his own company to do the same development work that BV Medical needed.

USES AND BENEFITS

Future market potential in the United States for laser angioplasty can be estimated from the number of angioplasty catheter and by-pass surgery procedures projected to take place within future time periods. According to figures obtained from BV Medical, the number of these traditional operations in 1988 is estimated to be close to 400,000. Although the purchase price of the BV Medical laser angioplasty unit is approximately $100,000, BV Medical estimates that potential revenue generation from its technology will be much greater, as the entire procedure of laser angioplasty involves two disposable units per operation.

Currently, BV Medical has received pre-market approval by the Food and Drug Administration (FDA), under Investigational Device Exemption status, to install their laser angioplasty product line on 20 sites in the United States. At this time, 11 units have been installed in the United States and 6 in foreign countries. The revenues generated from the sale of these units supports BV Medical in its ability to continually update and improve its current product line. With pending market approval from the FDA, the potential economic impact of laser angioplasty technology on the biomedical industry appears to be substantial.

DOE - Los Alamos National Laboratory

BIODEGRADABLE PLASTICS FROM CORN

A recently licensed patent of the Agricultural Research Service (ARS) is expected to lead to commercial production of biodegradable plastic for use in making garbage bags, food packaging, agricultural mulch and other plastic products. This technology, utilizing cornstarch, has been transferred by ARS scientists to a start-up company located near the laboratory where the invention was made. A Cooperative Research and Development Agreement has been signed by ARS and the company to enable ARS scientists to assist in the development of practical applications of injection molded products.

DOA - Agricultural Research Service

MICROELECTRONICS AND MILLIMETER WAVE RESEARCH

The Electronics Technology and Devices Laboratory, Fort Monmouth, NJ, and the National Science Foundation have formed a consortium with six select universities to attack critical "barrier" problems in high speed microelectronics and millimeter-wave communication research. This is the first such venture to be implemented under the Federal Technology Transfer Act of 1986 and the April 1987 Executive Order concerning technology transfer. Grants are being provided by the NSF to select university professors and doctoral students so that they may utilize the state-of-the-art microelectronics facilities at ETDL. Major General James C. Cercy, LABCOM, and Dr. Nam Suh, NSF's Assistant Director of Engineering, formally signed this agreement at a ceremony held at Fort Monmouth in May of 1987. This cooperative research program will benefit both academia and the government. A similar consortium under this ETDL-NSF agreement is now being considered in the area of superconductivity, again involving academia.

DOD - Army Electronics Technology and Devices Laboratory

THIN FILM ELECTROLUMINESCENT COLOR DISPLAYS

Electronics Technology and Devices Laboratory, Fort Monmouth, NJ is in the process of drawing up a contract for a tentative consortium aimed at the development of thin film electroluminescent color displays for both Army and commercial applications. The barrier problems to be overcome on this proposed program are luminescence and efficiency of the color phosphors, with efforts put on development of materials for full color electroluminescent displays. Industrial participants in this consortium along with ETDL are expected to include Norden Corporation and Westinghouse, Inc. The type of display screens to be developed would be valuable to the military. Their portability and high quality display make them adaptable to tanks, aircraft cockpits and computers for the front lines; likewise thin screen television will find application in commercial market for particular situations where cathode ray tubes may not be desirable.

DOD - Army Electronics Technology and Devices Laboratory

LOMA LINDA-FERMILAB PROJECT TO BUILD A PROTON ACCELERATOR FOR MEDICINE

In 1985, Fermilab was approached by the Loma Linda University Medical Center to collaborate on the design and construction of a complete facility for medical treatment with protons. Fermilab is now constructing the accelerator for Loma Linda under a work-for-others agreement. Loma Linda has also enlisted an industrial partner, SAIC, to participate in the project and produce later models of the accelerator. This technology should facilitate the adoption of the accelerator-based therapy into ever-widening use.

This accelerator project is a major step toward introducing modern accelerator construction techniques into use for a proven medical therapy that has several distinct advantages over ordinary x-rays. Conventional radiation can control cancer by killing cancerous cells, providing the absorbed dose is sufficient. But, because of the inability to selectively irradiate the cancer, normal tissues receive a similar dose and are damaged. As a consequence, a less than optimal total dose is frequently used in order to reduce unacceptable normal tissue damage. This results in a level of local disease control that varies for different types, stages and location of cancer.

The failure to effect local control of tumors is a fatal problem in over 100,000 patients each year in the United States. One approach to improve the incidence of local disease control is to reduce the dose delivered to surround normal tissues, while increasing the tumor dose. Heavy charged particles such as protons have very significant advantages for this approach. The dose distribution along the range of a proton beam will allow the therapist to reduce the does delivered to normal tissues by a factor of 2 to 5.

A conceptual design for the Loma Linda proton accelerator has already been completed at Fermilab. Construction of the accelerator is underway. It will be tested at Fermilab through 1988. The accelerator energy has been chosen to be 250 MeV in order to irradiate the deepest tumors from any angle. The intensity is such that the largest possible tumor can be irradiated in two minutes. The accelerator is approximately 20 feet in diameter. The Loma Linda system also include sophisticated beam-transport and beam-delivery systems that carry the beams to patients.

DOE - Fermi National Accelerator Laboratory

COMPOUND SEPARATION

Liquid-liquid extraction is a term used in chemical laboratory work to describe a method of separating various chemical compounds contained within biological liquids, such as blood or urine samples. Used for such purposes as medical treatment, pharmaceutical preparation, and forensic chemistry, extraction is a process whereby the compounds to be separated are transferred to a solvent liquid in a series of complicated, time-consuming steps requiring a variety of special equipment.

Looking for a simpler, easier way to separate compounds, Jet Propulsion Laboratory (JPL) developed a new one-step liquid-liquid extraction technique which sharply cuts processing time, reduces costs, and eliminates much of the equipment requirement. The technique employs disposable "extraction columns," or tubes, partially filled with an inert, water-absorbent granular matrix. These columns are now produced commercially by Analytichem International, Inc., Harbor City, California, under the trade name Extube.

In a typical extraction, a liquid sample is poured into an Extube where the filling material absorbs water and impurities from the sample and spreads the specimen as a very thin film over a large area. To extract a particular compound, an appropriate liquid solvent is introduced to the tube. As the solvent passes through the filling material, the desired compound becomes dissolved in the solvent and exits through the tube's nozzle. A different compound may be extracted from the remaining sample by introducing another solvent.

JPL's original development was undertaken as an aid to the Los Angeles Police Department, allowing more rapid detection of drugs in biological samples as part of the department's drug abuse program. NASA waived title to the invention to the California Institute of Technology (Caltech), JPL's parent organization, and Analytichem International is producing Extubes under Caltech license.

NASA - Jet Propulsion Laboratory

GENETISCAN - CHROMOSOME KARYOTYPING SYSTEM, CHROMOSOME ANALYSIS SYSTEM, AND SYSTEMS FOR CYTOGENETIC IMAGING

These systems support obstetricians and their patients in karyotyping chromosomes for making decisions on the health and quality of life of the unborn child and also supports cytologists in other disciplines. The development was derived from techniques at JPL in image processing for space and planetary imaging.

The field of medicine proved to be highly receptive to transfer of image processing technology. And once again, it was Jet Propulsion Laboratory that pointed the way. In the 1960s, Drs. Robert Nathan, Robert Selzer and Kenneth Castleman pioneered use of space-derived digital image processing techniques to enhance electron microscope, x-ray and light microscope images. This work sparked experimental medical applications by other organizations and emergence of a growing industry providing hardware, software and services for non-aerospace uses of image processing technology. Some of the companies were old-line firms that had worked with NASA from the earliest days. Others were new firms specially formed to commercialize the technology, many of them founded by former employees of NASA or space image processing contractors.

An example is Perceptive Systems Inc. (PSI). The company's initial technology development was an extension of work in computerized chromosome analysis Castleman and others had started at JPL. The product of that technology is PSI's Genetiscan digital karyotyping system. The Genetiscan system eliminates the need for photography, including the hours of darkroom time, and the tedious manual assembly of karyotypes. It employs a video camera mounted on a microscope to capture chromosome images, which are then converted to digital form for processing. Genetiscan offers the ability to improve image quality; it can enhance the contrast of chromosomes, correct for shading in the microscope, and perform several proprietary PSI image enhancement operations.

PSI is one of a growing number of companies producing image processing systems for an expanding range of medical uses. Among medical applications are computerized tomography (CAT) scanning diagnostic radiography, brain or cardiac angiography, monitoring surgery and diagnostic nuclear magnetic resonance, a relatively new body scanning technique.

A special application of interest is the mobile diagnostic laboratory built by Remote Imaging System, a division of Portable X-Ray Labs Inc., Anaheim, CA. Contained in a van equipped with a variety of processing equipment, the remote imaging lab is dispatched to a site where an x-ray, ultrasound, electrocardiographic or other type of examination is required. The information acquired on film or hardcopy is digitized and sent over standard telephone lines to a diagnostic center, where a physician interprets the data, provides a written diagnosis and transmits it back to a computer printer in the lab - all within minutes. The system can transfer images between hospitals, clinics or other physician locations and it can be used to communicate with specialists for a second opinion.

NASA - Jet Propulsion Laboratory

WELL DRILLING STRESS MEASUREMENT

Knowledge of the in situ stress state at depth is critical to the petroleum industry for optimum location and spacing of production wells in enhanced oil and gas recovery projects, where hydraulic fracturing is the dominant stimulation method. In situ stress is the predominant parameter affecting hydraulic fracture propagation. The economic importance of in situ stress measurements and their relation to hydraulic fracture azimuth and geometry is reflected in the results of an industry survey sponsored by the U.S. Department of Energy (DOE), which reported that out of ten R&D objectives in fracture stimulation for enhanced recovery, the ones given first and second rank in importance were (1) prediction and/or control of fracture azimuth and geometry and (2) measurement of in situ stress to better predict fracture azimuth and geometry. While knowledge os in situ stress is important, obtaining accurate measurements is often difficult. Dr. Lawrence W. Teufel has developed a new stress measurement technique which is based upon anelastic strain recovery (ASR) measurements (i.e., time-dependent strain relaxation) of oriented core from deep wells. The method is simpler and less expensive than conventional stress measurement techniques used in deep wells. Field tests to evaluate the technique's accuracy in determining the principal horizontal in situ stress directions and hydraulic fracture azimuth were made in DOE sponsored wells at the Nevada Test Site and in Colorado, as well as in cooperative experiments with industry (including Arco, Amoco, British Petroleum, Exxon, Mobil, and Shell), where the predicted hydraulic fracture azimuth from ASR measurements could be compared directly with the fracture azimuth determined by expensive surface and downhole geophysical techniques and long-term production analysis and modelling of the reservoir. The ASR method was successful in determining the fracture azimuth in all of these field experiments and proved to be as accurate as the more expensive geophysical methods. Industry became very interested in the ASR technique and technology transfer was made during the course of these field experiments via extensive on-site demonstrations and discussions of the technique's instrumentation, procedures, and data analysis with industry participants, by presentations at technical meetings and publications on the technique and results of the field tests, and through a technology transfer workshop hosted by Litton Core Lab for the U.S. oil industry research labs. Recently independent verification of the technique has been made and reported by Exxon and Halliburton. Several oil field service companies (Terra Tek, Rock Mechanics A/S, Halliburton, and Litton Core Lab) are now in the process of offering the ASR method as a routine, commercial service for determining hydraulic fracture azimuth. In 1985 Dr. Teufel received the U.S. National Committee for Rock Mechanics (of the National Research Council) Applied Research Award for two papers on the development and application of the ASR technique to hydraulic fracturing. He is currently involved in a cooperative research program with Phillips Petroleum to extend the application of the ASR stress measurement technique to the problems of subsidence and enhanced oil recovery in fractured chalk reservoirs in the North Sea.

DOE - Sandia National Laboratories

INTEGRATED CIRCUITS

Reflective notching is a widespread problem in the patterning of integrated circuits, both at Sandia and in industry. Notching results from the reflection of light off the surface being patterned, causing exposure of the photosensitive resist material in areas which should have remained unexposed. This results in wavy or notched lines instead of straight, uniform ones. Since no commercial product was available to rectify Sandia's particularly severe notching problem, a resist formulation was developed in-house using curcumin as the dye. Curcumin is nearly ideal for this application and the resist eliminated the notching problem here. It is now being used in all Sandia metal-level patterning, and is produced in production volumes for Sandia by KTI Chemicals.

Just before this invention was to be publicly disclosed, it was discovered that the Shipley Company, the world's largest manufacturer of positive photoresist, had independently produced a formulation based on the same dye at about the same time. Shipley management was quite concerned that disclosure of the Sandia "recipe" at that time would allow other companies, particularly non-U.S. concerns, to quickly produce a similar product and compromise Shipley's considerable investment in the product. Therefore, an agreement was reached whereby public disclosure by Sandia would be delayed by about two months, until the Shipley product was fully commercialized. The Shipley product is now on the market and sales are exceeding expectations. In return, Shipley has credited Sandia in their advertising. As a result of the interaction on the resist problem, Shipley's top management visited Sandia to explore possible areas of future collaboration. The Sandia work has now been disclosed, and presentations at two DOE-sponsored conferences, the American Chemical Society Fall 87 National Meeting, and an invited seminar at the University of Connecticut. In addition, a short paper has been published in the Journal of the Electrochem. Soc., with a full paper to be submitted there shortly.

DOE - Sandia National Laboratories

AIR POLLUTION IMPROVEMENT

Members of the Applied Atmospheric Research Group at Sandia National Laboratories have been involved in a study of Dallas winter season air pollution episodes and their related impact on visibility in cooperation with the Texas Air Control Board, a state agency responsible for the development and implementation of air pollution monitoring and control strategies. The transfer of ambient air monitoring and data analysis skills, employed in earlier studies at Sandia, to this state agency was made possible by this cooperative study with the Texas Air Control Board. The Dallas Winter Visibility Study, conducted with EPA funds during the 1986-87 winter season, is a receptor modeling study which makes possible the determination of air pollution impacts from major sources within the Dallas region on the total observed visibility impairment. Analysis techniques employed in this current study were successfully used and refined by Sandia researchers in a similar study of Albuquerque winter season pollution episodes conducted several years ago. The analysis technique allows a determination of the contribution of typical urban source categories such as vehicles, crustal, residential wood combustion and coal-fired power plants to measured visibility impairment. The method employs the use of elemental tracer concentrations as measured in aerosol samples collected from ambient air and statistical regression techniques to predict the contribution of major source categories within the urban environment to observe pollution severity. These acquired skills will enable this agency to come to a better understanding of existing air pollution problems in the state of Texas and allow for the development of relevant air pollution control strategies.

DOE - Sandia National Laboratories

MERCURY CADMIUM TELLURIDE INFRARED DETECTORS

Researchers at the Naval Weapons Center (NWC) have developed new compounds that are being used in the semiconductor industry to produce infrared detectors for surveillance and guidance systems. The disposition of mercury cadmium telluride films for these detectors has been plagued by the high temperatures needed for their production. Elevated deposition temperatures cause degradation of device performance. New tellurium and cadmium compounds invented at NWC allow deposition of films at significantly lower temperature than previously possible. Film growth experiments with the NWC compounds are presently in progress at Raytheon Research Division, Santa Barbara Research Center, Hughes Malibu Laboratory, AT&T Bell Laboratories and Royal Signals and Radar Establishment in Great Britain. This work has lead to at least three patent applications by NWC personnel and at least one research publication. A commercial vendor is seeking licensing rights from the government to manufacture and market these new compounds for the semiconductor industry.

DOD - Naval Weapons Center

THE IMPACT OF TEVATRON TECHNOLOGY

The development of the Tevatron accelerator at Fermilab helped to lay the foundation for a new industry in the United States -- the superconductivity industry. This industry has the potential to grow to the scale of the present liquid nitrogen and liquified natural gas industries with applications permeating many sectors of the economy. For example, superconducting technology is being used in hundreds of whole-body NMR scanners that are now being produced. The technology is useful for superconducting power lines, high-speed rail transport, large fusion magnets, and even metal and garbage separation. Obviously, Tevatron technology is crucial to the development of a Superconducting Super Collider (SSC). Without the Tevatron proof of principle it would not be possible to contemplate a realistic SSC. Tevatron development has contributed to the development of superconducting wire, superconducting magnets, helium cryogenic facilities, cryogenic and vacuum components, and helium refrigeration control and simulation.

DOE - Fermi National Accelerator Laboratory

MILLIMETER WAVE FERRITE MATERIALS

Electronics Technology and Devices Laboratory, Fort Monmouth, NJ, has let Small Business Innovation Research (SBIR) contracts to 24 companies for approximately $2,000,000 and is in the process of converting about 20% of those contracts into technology transfer programs under the Federal Technology Transfer Act of 1986 and the April 1987 Executive Order concerning technology transfer. This process occurs when the SBIR Phase II contracts are completed and enter the arena of Phase III (no Federal funds utilized). The first program to be converted is a highly successful SBIR program in the area of improved ferrite materials. This SBIR program, involving Electromagnetic Sciences, Inc. together with Georgia Tech, produced more efficient, reproducible ferrite materials for millimeter wave radar and communications applications. These new ferrite materials are already positively impacting DOD and NASA communication satellite programs and additional classified program efforts. Contracts have been drawn up for this new consortium which will have the participants evaluating and adapting these new ferrite materials and associated devices for millimeter wave high power applications for communication satellite programs. This effort will be carried out at ETD laboratory's state-of-the-art millimeter wave high power facility. Spin-offs into the commercial satellite communications arena are expected.

DOD - Army Electronics Technology and Devices Laboratory

TEACHING AN OLD CODE NEW TRICKS: COMMIX CODE FOR METAL CASTING

THE TECHNOLOGY

Although the casting process is one of the oldest known metallurgical techniques, it involves a host of complex phenomena that are still not thoroughly understood. Often the desired casting shape is highly irregular, so the casting mold is complicated. A host of complex factors rule out a purely analytical analysis of the process. But now, with the development of advanced computer technology and sophisticated numerical methods, the phenomena that affect the casting process can be characterized and better understood, leading to the development of computer-aided design and the fabrication of near net-shape products.

Argonne has developed a state-of-the-art computer program called COMMIX that can model complex fluid flow and heat transfer--the primary phenomena involved in casting. COMMIX was developed with funding from the U.S. Nuclear Regulatory Commission, U.S. Department of Energy, and Electric Power Research Institute over the past ten years to describe fluid flow and heat transfer in reactor cooling systems. The cumulative cost for the development and validation is approximately ten million dollars. COMMIX was developed to analyze nuclear reactor systems, but is a general-purpose, well-tested code that can be used to analyze a wide variety of heat transfer and fluid flow phenomena in other complex industrial systems. It is currently used by more than 50 industrial and research organizations.

TECHNOLOGY RECIPIENTS

Argonne is working in partnership with Lester B. Knight and the Department of Energy to form a consortium to develop COMMIX as a design tool for the casting industry. briefings have been given to a number of major casting firms with the proposal to jointly fund a two year program to develop a generic code. A Phase II program will involve a series of proprietary studies with individual firms to tailor the code to their specific needs.

USES AND BENEFITS

COMMIX can readily be applied to model the complex shapes inherent in casting. It can be used for any material to produce any shape or size of casting. The modifications needed to describe stages of the casting process can be done relatively easily, quickly, and inexpensively. The basic formulation of COMMIX is better suited to complex geometrical shapes than are other finite-volume fluid-flow/heat transfer codes.

DOE - Argonne National Laboratory

METAL-VAPOR VACUUM ARC (MEVVA) ION SOURCE

Development and technology transfer of MEVVA technology continued in 1987. Because of the high ion intensities available from this LBL-invented source, it has possible applications in several areas. Those pursued during the past year as part of academic research program sand in industry included ion implantation (for metallurgical surface modification and integrated circuit applications), surface diagnostics, and accelerator applications. Guidance and technical information were provided to ISM Technologies, Inc., a start-up company established solely to commercialize MEVVA technology, 3M Corporation, AT&T Bell Laboratories, Texas A&M University, Cornell University and Kansas State University.

DOE - Lawrence Berkeley Laboratory

SUPERCONDUCTING CABLE

Transfer of superconducting cable technology continued in 1987. In particular, the technology developed at the Lawrence Berkeley Laboratory for winding superconducting cable continues to be transferred to New England Electric Wire. A cable-winding machine built to our specifications will be installed there in 1988 and will be the initial source of cable for the proposed Superconducting Super Collider. Construction of the SSC could mean $250 million in business for suppliers of superconducting material and cable.

DOE - Lawrence Berkeley Laboratory

ANEMIA AND IMMUNOSUPPRESSION

Research efforts continue at Lawrence Berkeley Laboratory to determine the basis for the anemia and immunosuppression associated with malaria infection. Products of the immune system, such as interleukins and tumor necrosis factor, appear to be involved via their effects on blood cell precursors. We are currently collaborating with Dr. George Kuo of Chiron Corporation and Dr. Ivan Otterness of Pfizer to investigate the regulatory role of these factors in blood cell development and in the pathology of malaria. These studies will increase our understanding of the regulation of blood cell development and aid in the development of therapeutic strategies for the anemia and immunosuppression associated with infectious diseases such as malaria. In addition, LBL provided educational opportunities for two high school science teachers for six weeks.

DOE - Lawrence Berkeley Laboratory

MODIFIED NUCLEOTIDES

With Dr. Kusmierek of the Polish Academy of Sciences, Warsaw, Poland, scientists at the Lawrence Berkeley Laboratory have synthesized the ribodiphosphate of a nucleoside that results from the action of the human carcinogen, vinyl chloride, and have shown that it has a high mutagenic potential in in vitro systems. This nucleoside is being used by Dr. J. Swenberg (C.I.I.T., Research Triangle Park, NC) as a marker for studies of animal exposure to vinyl chloride. A second aspect of vinyl chloride carcinogensis is the occurrence of crosslinks. With Dr. R. Laib (University of Dortmund, West Germany), we are investigating the occurrence of crosslinks in the DNA of rats exposed to $_{14}$C-vinyl chloride by inhalation, the normal route of human exposure. Repair of both types of lesions is being studied in preliminary work with Dr. W.J. Bodel (UCSF), using cell lines that originated in tumors that are either resistant or sensitive to crosslinking chemotherapeutic agents.

Structural studies of carcinogen-modified mucleosides have been done in collaboration with Dr. D. Jensen (Temple University School of Medicine), determining the fluroescence of N^2, 3-ethenoguanosine and the effect of incorporation into nucleic acids. Dr. J. Essigmann (M.I.T.) has prepared defined oligomers containing two other etheno derivatives that we are using in replication systems to measure fidelity and mutagenic potential. Two other collaborations on polymerase fidelity with modified nucleosides are in progress. The first involves site-directed mutagenesis studies with Dr. L. Loeb (University of Washington). This in vivo system is complemented by studies on eukaryotic polymerases with Dr. M. Goodman (U.S.C.). Here, the in vitro kinetics of incorporation of modified triposphates at defined positions in nucleic acids is measured by a gel assay.

These collaborations have facilitated an understanding of the mechanisms of carcinogenesis by vinyl chloride and other alkylating agents, as well as to develop non-invasive methods for estimation of exposure and risk to human populations.

DOE - Lawrence Berkeley Laboratory

SPOCK SUPERCOMPUTER

The Georgia Institute of Technology Research Institute (GTRI), under contract to the Army Strategic Defense Command has developed Very Large Scale Integrated Circuit (VLSI) computer technology which combines hardware, computer code, and semi-conductor devices for guidance and control simulations of SDI ground Based Interceptors. This technology, known as Special Purpose Operational Computing Kernal (SPOCK) has been licensed to Advanced Cybernetic Technology, Inc. in Rockville, MD for commercial computer applications. The arrangement provides for a 5% royalty to GTRI and a 1.3% royalty to the government on all sales.

DOD - Strategic Defense Initiatives Organization

NEW MATERIALS FOR AUTOMOTIVE AND AEROSPACE APPLICATIONS

Methods for extending material properties by means of a carbon fibre matrix/carbon fibre coating technology originally investigated under a SDI Small Business Innovative Research (SBIR) contract are being evaluated for use in a number of automotive and turbine engine applications. Evaluations in progress include applications of the high temperature carbon fibre ceramic materials for automobile gasoline and diesel engine components (e.g. turbosuperchargers) as well as jet engine turbine blades. The SDIO Office of Technology Applications, working through the American Automobile Manufacturers Association, initiated a number of investigations by Ford, GM, and Chrysler and by several aircraft engine companies. GM Detroit Diesel has requested the small business contractor to provide material test samples for engine components and Chrysler Corporation in negotiating to procure 12.5 million ceramic cam follower rollers for 2.2 liter and 2.4 liter 4 cylinder overhead cam engines for the 1989 model year. Chrysler has also requested test samples for a suspension component. Components in advanced Chrysler engines are being investigated for introduction in 1992. Williams Turbine is investigating the process for turbine blade applications, and the General Electric Company has signed an agreement to evaluate proprietary materials for an aircraft engine application. General Motors is investigating component applications for their low heat rejection, adiabatic diesel engine now in development.

DOD - Strategic Defense Initiatives Organization

APPLICATIONS OF PULSE POWER TRANSMISSION TECHNOLOGY TO OIL WELL DRILLING

Research originally completed under SDI contract for the transmission of high energy pulsed power is now being expanded under a grant from the Department of Energy to applications for fracturing rock strata in oil well drilling by a small business in New Mexico.

DOD - Strategic Defense Initiatives Organization

SUPERCONDUCTING MAGNETIC ENERGY STORAGE SYSTEM

SDIO, in cooperation with the Department of Energy and the Electrical Power Research Institute, is beginning a five year effort to build a Superconducting Magnetic Energy Storage (SMES) system. After competitive proposals were solicited, a contract award was made in November 87 to Ebasco Services Inc. of New York who will work with Madison Gas and Electric Co. of Wisconsin and the University of Wisconsin and Bechtel National Inc. of San Francisco. The program has the dual objectives of demonstrating the feasibility of using SMES technology to provide SDI ground power and using the same technology to provide load leveling for commercial electrical utilities. Thus civilian use of this SDI developed technology will not be merely a by-product, but an integral part of the concept from inception. It is only through SDI's critical role as a "catalyst" that exploitation and early electrical utility application of this technology has been made possible.

DOD - Strategic Defense Initiatives Organization

GEOGRAPHIC INFORMATION SYSTEMS

The U.S. Geological Survey is a world leader in the development of the use of Geographic Information Systems (GIS) in the civilian sector. A demonstration project was prepared jointly by the U.S. Geological Survey and the Connecticut Department of Environmental Protection on the Broad Brook and Ellington 7.5-minute quadrangle areas in Connecticut. It was first presented at a meeting of the Association of American State Geologists in June 1985 and subsequently at a number of other conventions. It has become commonly used in training of the public in the ARC/INFO GIS system. In late 1986, a Geographic Information Systems Laboratory was established at Reston, VA, that is already receiving great attention from the public, and others are being established at Denver, CO and Menlo Park, CA. The U.S. Geological Survey efforts in GIS have been described in a number of places, including the U.S. Geological Survey Yearbook for Fiscal Year 1985 (available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402). The principal contact is David A. Nystrom, U.S. Geological Survey, 521 National Center, Reston, VA, 22092, telephone number 703/648-4505, FTS 959-4505.

DOI - U.S. Geological Survey

SECTION B

WORKSHOPS, SEMINARS AND BRIEFINGS

X-RAY LITHOGRAPHY SYNCHROTRON (XLS)

THE TECHNOLOGY

An electron synchrotron storage ring optimized for use in manufacturing high density semiconductors. This ring is the only source that is capable of supporting high resolution <0.35 micron technology for the mass production of 256 megabit and larger chips. Concurrently, industry must develop the ancillary process technology (steppers, masks, resists, aligners, etc).

TECHNOLOGY RECIPIENTS

United States companies who would manufacture synchrotrons and sell them to computer manufacturers are the initial benefactors. As a result of three workshops held in 1986, recommendations were forthcoming from the industrial participants to build a prototype ambient temperature light source while performing research on magnets for a cryogenic compact source. Process technology will begin at Aladdin at the University of Wisconsin while the prototype is being built and a 0.25 micro process technology effort should be centered on the optimized beam at BNL as soon as possible. At the third workshop the cost of an x-ray lithography program was estimated at $400 million over six years. Of this, only about $60 million was for the prototype synchrotron sources.

One million dollars was supplied by DOD in March, 1987. A quarter of this has been spent at Wisconsin to plan for the process development activities there and the rest at Brookhaven to plan for a prototype synchrotron source. In July, 1987, as part of the Brookhaven planning study, a technology transfer workshop was convened. Nine companies with an interest in participating in the prototype program as potential suppliers attended. A consensus agreement as to the approach to be used to transfer the technology emerged from the workshop and is reported on in the workshop proceedings.

Congress has included in the FY 1988 appropriations bills approximately seventeen million dollars to initiate construction of a prototype x-ray lithography synchrotron at Brookhaven. Twelve million dollars has been appropriated for a parallel effort at Louisiana State University.

USES AND BENEFITS

The mass produced billion bit memory chip will become the key element for supercomputer manufacture in the mid-1990's. It will also be the basis of other large and small advanced computer applications including robotics, CAD/CAM/CAE, expert systems and artificial intelligence, and other advances that will increase productivity, assure national economic competitiveness and security while maintaining U.S. industrial leadership. If the U.S. does not have a homegrown set of process technology vendors, American chip manufacturers and large scale users will be dependent upon foreign machinery. If the U.S. is slow to start, it is quite possible that the first quality and newest high density manufacturing equipment will be available only to large vertically integrated foreign manufacturers.

DOE - Brookhaven National Laboratory

KDP CRYSTAL INDUSTRY LEAPS FORWARD

THE TECHNOLOGY

LLNL scientists are continuing to advance the state of the KDP (Potassium Dihydrogen Phosphate) crystal industry by learning how to significantly improve methods of growing, cutting and polishing the fragile material. Through a new LLNL procedure, crystals are being formed 10 times faster than the current industrial rate, and at greatly reduced cost. A closely related program seeks to produce crystals that are more resistant to damage from intense laser light. When fully developed, rapid-growth technology will be transferred to the crystal industry, which in turn is expected to continue its development of large-scale production capability. LLNL also is continuing to share its knowledge of machining KDP crystals with state of the art diamond turning machines.

TECHNOLOGY RECIPIENTS

Lab scientists have made countless trips around the country to share knowledge and advice about growing, analyzing, handling, machining and polishing KDP. When they began their effort, the largest KDP crystal was the size of an apple; two years later companies were growing crystals standing three feet tall and weighing several hundred pounds. Called boules, they look like giant pyramidal chunks of rock candy. Ohio's Cleveland Crystals now has the unique capability to produce the largest KDP crystals available and is recognized as the world's prime supplier.

Livermore employees also have helped American crystal growers learn diamond turning machine technology to finish KDP crystals to a smoothness impossible to achieve with conventional machining techniques. This technology was formally transferred to 14 U.S. companies through LLNL-sponsored technology transfer workshops. LLNL funded the construction of diamond turning machines and related measurement equipment at Cleveland Crystals and Pneumo Precision, New Hampshire. Cleveland expanded its product line and Pneumo Precision established a new facility near LLNL. Both firms report growing sales worldwide and are continuing to work closely with LLNL to expand their technical base.

USES AND BENEFITS

KDP crystals improve laser fusion experiments by converting laser light to higher frequencies. American companies are now supplying KDP components to the Japanese, British and French laser fusion programs. With significant advances on the horizon from LLNL for speeding crystal growth, the industry's future looks bright.

DOE - Lawrence Livermore National Laboratory

ADVANCED ACCELERATOR MAY REPLACE CHEMICALS IN PROCESSING OF FOOD

THE TECHNOLOGY

Laboratory researchers have developed a small linear induction accelerator capable of generating a very high powered electron beam. This device could serve as a relatively inexpensive treatment source for a number of commercial processes, particularly food processing and preservation. LLNL's design uses highly reliable and efficient magnetic generators to produce high intensity burst of electrons with pulse power averaging several megawatts. The design is a spinoff of LLNL directed energy research conducted for the Strategic Defense Initiative. A 2-million electron volt machine has been successfully used in a series of food preservation experiments carried out by LLNL and the University of California at Davis.

TECHNOLOGY RECIPIENTS

More than 60 industry representatives have been briefed by Laboratory experts on the capability of the linear accelerator. LLNL is assisting a small corporation which has been awarded a DOE Small Business Innovative Research grant, entitled "Advanced Accelerator Development for Industrial Applications." The assistance is in the form of temporary loans of unused equipment and technical consultation and advice. In addition, negotiations are under way to license applicable patented technology to the firm. The company's goal is to develop and market commercial accelerators for food treatment and medical equipment sterilization.

COMMERCIAL USES AND BENEFITS

Even though farmers protect their crops with chemicals, pests and diseases still destroy one-third of the nation's annual harvest. The LLNL accelerator should provide unmatched capabilities for use against insect infestation of harvested fruits and vegetables, as well as a means to extend the shelf life of many foodstuffs, including grains. It is a safe alternative to chemical fumigants.

Studies by LLNL beam energy experts show that the operating cost of processing a tone of food with their accelerator is about half of what it would cost with current chemical methods of disinfestation and fumigation. Electron doses can vary, ranging from low level to inhibit insects to high levels to sterilize for long-term preservation and the elimination of viruses.

DOE - Lawrence Livermore National Laboratory

QUICK AND ACCURATE DETERMINATION OF HENRY'S LAW CONSTANTS

THE TECHNOLOGY

Under an AF-funded project, Engineers at Cornell University developed a simple technique to experimentally determine Henry's law constants for environmental applications. The technology, commonly referred to as Equilibrium Partitioning in Closed System (EPICS), requires no special apparatus, just two equal volume bottles. Results are obtained from the measurement of gas concentration ratios between the pair of sealed bottles, each having different liquid volumes. The EPICS technique enables quick and accurate determination of Henry's law constants for volatile organic compounds (VOCs) in water. Reliable and reproducible values of Henry's law constants are obtained for VOCs of varying type and volatility. This information is required in the planning and design of hazardous waste treatment system. It is vital for determining the environmental fate and transport of hazardous substances in subsurface aquifers.

TECHNOLOGY RECIPIENTS

Air Force Engineering and Services Center (AFESC), through technical reports and presentations, has directly transferred the technology and experimental data to 75 Department of Defense organizations, 19 Federal laboratories, as well as 25 universities and civilian engineering firms. Indirect transfer of the technology has been accomplished through numerous presentations at national conferences and publications in engineering and technological journals. At one conference alone, over 200 reprints were requested. A majority of the recipients are engineers and scientists responsible for understanding, identifying and cleaning up contaminated groundwater and soils.

USES AND BENEFITS

Henry's law constants are required during the planning and design of groundwater treatment systems (e.g., air stripping). The constants are used for calculations where contaminated water and air are in contact. The EPICS procedure is a quick and accurate method for determining Henry's law constants. The resulting constants provide a reliable and reproducible source of environmental data for consulting engineers and scientists. Ultimately, the data obtained from the EPICS procedure can be used to reduce the uncertainty during design, resulting in efficient and cost-effective groundwater treatment systems.

DOD - Air Force Engineering & Services Center

THE CHEMIST'S WORKBENCH

THE TECHNOLOGY

The Molecular Modeling, Analysis, and Display System (MMADS) has been developed for 'state of the art' computer-assisted modeling for chemicals. It is an integrated set of theoretical and physical organic chemistry programs, a computer network, and color graphics display devices that allow a research scientist to generate, manipulate, and analyze three-dimensional conformation of chemical compounds either individually or with the three dimensional conformation or representation of biological receptors. Even though the system supports over 100 commands, it requires minimal understanding of computers or computer programming. Furthermore, the user need only know very elementary chemistry in order to enter, manipulate, and perform calculations on new chemical structures.

TECHNOLOGY RECIPIENTS

UNIVERSITIES
Duke University
Lehigh University
University of Illinois at Chicago
Villanova University
University of Pennsylvania
Pratt Institute
University of California at Riverside
California Polytechnical Institute
Loma Linda University
University of California at Los Angeles

CORPORATE USERS
The UpJohn Company
Biofor, Incorporated
Allied Signal
Eastman Kodak Company
Tetra-Tech, Incorporated

OTHER GOVERNMENT AGENCIES
Naval Research Laboratory
National Institutes of Health/Nat. Cancer Institute
Naval Surface Weapons Center
Lawrence Livermore Laboratory
Naval Weapons Center
U.S. Air Force Academy
Eglin Air Force Base
U.S. Army Med. Research Inst. of Chemical Defense

The utility of the system has been demonstrated at technical meetings and other scientific gatherings.

USES AND BENEFITS

At least two of the universities are developing an undergraduate training program in chemistry using MMADS to demonstrate elementary principles of chemical bonding, valence, and reactivity as well as supporting graduate research. Other users have employed the system to develop structure-activity relationships of the toxicity of chemical compounds, to predict chemical, physiological or physical properties of new chemicals, and to design novel coatings for detection devices.

DOD - Army Chemical Research, Development and Engineering Center

ULTRA CLEAN STEEL

THE TECHNOLOGY

As the requirements for ultra-high strength steel increase, the steel industry has been challenged to improve the steel making practice to control inclusions, using ladle treatment instead of secondary refining. One use for these steels is in the production of steel for gun tube forgings. Currently, steel is procured as right circular cylinders, and then, at Watervliet Arsenal, rotary forged and heat treated. Thus, the steel producer does not know the effects of his practice directly. Benet Laboratories, located at Watervliet Arsenal, maintains surveillance over both the steel and its subsequent processing. Cooperative studies have been run to determine the relationship between steel making and final product. This work is intensified when there are periodic problems. Through these cooperative studies and by regular dialogue between Laboratory and the steel producers, it has been possible for the producer to establish control over the steel making practice to improve cleanliness and yield a forging with exceptional mechanical properties.

TECHNOLOGY RECIPIENTS

The steel producers involved in the production of steel for gun tube forgings are the direct recipients of this technology for general use, as well as for gun tube forgings. But, certain facets of the technology have been made available generally, to the steel industry, through reports, presentations and plant visits. These deal with the relationships between cleanliness and mechanical properties. (The processing technique used by steel producers is considered propriety and producer-specific.)

USES AND BENEFITS

This technology has general use in the design with, and production of, ultra-high strength steel. These cooperative efforts have led to the development of economical and effective processing technology for inclusion control which is ultimately translated to a higher quality product. When it is properly controlled, it has allowed the use of less costly ladle treated steels in lieu of more expensive secondary_refined steels.

DOD - Army Benet Laboratory

NEW LIGHTWEIGHT WHEELCHAIR

THE TECHNOLOGY

Skin-stiffened structures are "sandwiches" consisting of strong, stiff outer layers and a lightweight interior. The outer layers, typically graphite and/or Kevlar reinforced composites, provide the structural strength and rigidity while the interior, typically foam materials, minimize the weight of the structure. This technology has been widely used by NASA in applications requiring structural strength and minimum weight for aerospace applications. This composite technology has been applied to wheelchair design by using skin-stiffened structures for the side panels, seat assembly, and foot rest. Composite material is utilized also for the specially designed hand rims. The result is a lightweight wheelchair with an overall weight of about 25 lbs. The composite materials are graphite and Kevlar reinforced epoxy prepeg with a high temperature foam core. Composites are inherently resistant to damage by fluids and have excellent fatigue resistance compared to metals Pigmenting or surface painting are optional. In addition, new design possibilities are offered by the new material.

TECHNOLOGY RECIPIENTS

Nearly 1,000,000 people in the USA rely on wheelchairs for mobility. Conventional metal wheelchairs are frequently heavy, difficult to handle, and also are subject to rust and corrosion. Some of these difficulties have been remedied through the efforts of a multi-organizational cooperative program which resulted in the design and fabrication of prototype, foldable wheelchairs constructed largely from aerospace-type composite materials. The chairs were designed by the University of Virginia's Rehabilitation Engineering Center with support from Langley Research Center; the compositive materials elements were fabricated at Langley Research Center. The National Institute for Handicapped Research also collaborated in the project. A workshop was conducted in 1985 to apprise prospective manufacturers of the design, fabrication, and assembly techniques appropriate to the composite wheelchair. Eleven companies were represented. One company, University Technologies, Inc., of Charlottesville, VA, has received a license to produce the composite chair.

USES AND BENEFITS

Approximately 200,000 wheelchairs are sold annually, and most of these share the common disadvantage of being heavy. The excess weight not only hampers the ability to lift and store the chair, but affects the handling characteristics. Most attempts to reduce the weight of wheelchairs have compromised the rigidity and stability of the chair or have sacrificed some general purpose features such as folding, braking, etc. The low weight of the composite wheelchair gives it the balance and weight of a sports char but with many general features. The chair folds easily to a size suitable for compact storage areas and is easily lifted. The solid seat is more comfortable than a sagging seat. The seat section and subframe are designed such that fore and aft adjustments can readily be made. The contoured back attaches by Velcro and is easily replaced when upholstery becomes worn.

NASA - Langley Research Center

INDOOR ANTENNA MEASUREMENTS REPLACE COSTLY OUTDOOR RANGES

THE TECHNOLOGY

Antennas are designed to send or receive signals in specific, often very sharply defined directions. Since the signals reflect from many surfaces, the testing of antennas has been complicated and costly. The planar near field method (PNFM), developed by the National Bureau of Standards, now makes it possible to make such measurements indoors. The method involves measuring the phase and amplitude distributions of the radiated field over a flat plane close to the antenna in a room designed to absorb, rather than reflect the signals. These data are then transformed by computer in accordance with rigorous theoretical algorithms to completely determine the radiation characteristics at the large distances from the antenna.

The advantages of PNFM are: (1) Measurements are performed in a controlled laboratory environment without regard to weather. (2) Inherently greater accuracy is achieved and more complete information is obtained. (3) Faults and problems can be diagnosed and design data obtained. (4) Great savings in time, money, labor and real estate are possible. (5) The method is capable of performing certain measurements and of evaluating some complex antennas which could not be accomplished by previous far-field measurement techniques.

To introduce the new technology to the antenna design and testing community, numerous technical papers were published; more than 30 reports were delivered at technical meetings; courses were given; three courses in near-field scanning were given at NBS, and workshops were given at NASA Lewis Research Center, Hughes Aircraft Company, Intelsat and TRW Corporation. NBS staff consulted extensively with antenna manufacturers and users to assist them in designing, constructing, and evaluating their own near field measurement facilities.

TECHNOLOGY RECIPIENTS

Nearly all new antenna measurement facilities are now indoors using the near-field design pioneered by NBS. Eighteen U.S. companies have built 30 near-field antenna measurement facilities and 11 additional facilities have been built by NATO members.

USES AND BENEFITS

Hughes Ground Systems Group uses the near-field technique as a diagnostic tool to check for flaws in complex phased-array antennas being built for the U.S. Army. TRW's Antenna Systems Laboratory uses the near-field technique for acceptance testing on all projects, noting that a seven mile long outdoor range would be required to match their indoor range. RCA saved over $6 million in building and testing costs for the Aegis radar antennas installed on 16 U.S. Navy cruisers.

DOC - National Bureau of Standards

OPEN SYSTEMS INTERCONNECTION FOR COMPUTERS

THE TECHNOLOGY

For information to move smoothly from one computer to another, common formats and protocols must be understood. An Open Systems Interconnection (OSI) set of rules has been widely adopted by major manufacturers, vendors and communication carriers with NBS serving as an honest broker to bring the many groups together. As a major demonstration of the use of these protocols, a group of twenty-one industry and government organizations have joined to select from the many options available in the protocols, those they will use in a demonstration of the power of the Open Systems Interconnections Network (OSINET). This requires development of test methods, verification of those test methods and company-to-company testing. A larger demonstration with over 50 participants is planned as a one time event during a June 1988 trade show.

TECHNOLOGY RECIPIENTS

More than 200 computer manufacturers, semiconductor manufacturing, word processing vendors, process control vendors, communication carriers, and industry and government users from the U.S., Canada, and Europe have participated in NBS Workshop for Implementors of OSI, an open international forum that developed detailed implementation specifications from OSI standards.

USES AND BENEFITS

OSINET plays a key role in speeding up the development and use of commercial network products that conform to international standards of OSI.

DOC - National Bureau of Standards

GAS LEAK STANDARDS

This project resulted in a national calibration service for gas leak standards which supports industry, government, and university laboratories. Calibrated leaks are used for product acceptance in testing hermetic seals, vacuum tubes, vacuum systems, nuclear reactors, and waste spectrometers, and residual gaws analyzers. Sandia National laboratories, in support of the Department of Energy weapons production complex, has developed over many years fundamental techniques to calibrate gas leaks over the range 1-$^{-8}$ to 10^{-14} moles/sec. Calibration of this equipment relies on time measurements and fundamental gas properties: volume, temperature, pressure. Recognizing that a national calibration capability was needed to meet the growing needs of industry and other government agencies, a transfer of this calibration technology between Sandia and the National Bureau of Standards (NBS) was accomplished from 1983 through 1986. Sandia provided NBS with expertise and experience in leak calibration techniques, a comparison leak calibration system, and several calibrated leak standards for cross-checking purposes, as well as $312K in funding and $50K in equipment. In July 1986, NBS announced a Special test service for helium leak calibrations over the range 10^{-8} to 10^{-11} moles/sec for temperatures from 0 degrees C to 50 degrees C.

As part of the joint effort, Sandia and NBS sponsored two Leak Calibration Workshops, one in Albuquerque, NM in August 1985 and a second in Gaithersburg, MD in September 1987. The workshops brought together over 100 people from industry, government, and universities who were interested in the use, design and calibration of reference gas leaks. The collaboration also resulted in several publications, including a joint paper entitled "Transfer Leak Studies and Comparisons of Primary Leak Standards at NBS and Sandia" which appeared in Journal Vacuum Science Technology 4 334 (1986).

DOE - Sandia National Laboratories

CALCULATING GROUND STATE PROPERTIES OF METALS AND ALLOYS

The Embedded Atom Method (EAM) is a semi-empirical approach of calculating the ground state properties of metals and alloys. It has been demonstrated that it produces accurate predictions of material properties such as phase stability, impurity diffusion, and mechanical behavior. We have taken extraordinary measures to make the method available to industry, universities, and national laboratories. In addition, we have interacted strongly through our Visiting Scientist Program with a number of interested scientists and engineers.

Specifically we have: 1) sponsored an international workshop to acquaint interested parties with the method and to demonstrate to them its predictive power; 2) distributed copies of computer software and data to thirty sites throughout the world; and 3) interacted personally with five long term visitors at Sandia National Laboratories in implementing the EAM to solve their problems. This active dissemination program has resulted in over thirty groups throughout the world in industry, universities, and national laboratories currently using the EAM.

Successful calculations using the EAM have increased our understanding of the role that impurities, e.g. hydrogen and helium, have on the embrittlement processes. By understanding the underlying physics we are able to develop embrittlement resistant materials. The fracture process in the high temperature material nickel-aluminde has been shown to occur on grain boundaries as is seen experimentally. By investigating and understanding the effects of impurities on these boundaries a ductile material may be produced. Calculations of stable and metastable surface phases due to alloy constituents or strain have been performed. Investigations of the interaction of such surfaces with reactive gas species will allow the rapid development of new catalyst materials.

DOE - Sandia National Laboratories

INTEGRATED CIRCUIT MANUFACTURING

The properties of tungsten make it an ideal candidate to solve a host of material and electrical problems which are encountered in integrated circuit manufacture as microchip features shrink to one micron and below. Sandia has successfully demonstrated that selectively deposited layers of tungsten can be formed on silicon device wafers in sufficient thickness, and with adequate manufacturing control, to qualify this element as only the third material to be used in elemental form in IC devices since their invention more than thirty years ago. In addition to the physical property advantages of tungsten, the deposition process is self-aligning as a consequence of the selective nature of the chemical vapor deposition technique.

Sandia contributed to the development and growing use of tungsten in the IC community in four ways:

1. At a time when others were losing hope that a successful process would emerge, Sandia demonstrated the technical feasibility of depositing tungsten layers of sufficient thickness for intergrated circuit needs (up to 3 times thicker than had previously been possible) without losing the really selective (self-aligning) nature of the deposit.

2. Sandia released key elements of two successful thick film processes for presentation and publication at national meetings. Sandia also generated feasibility data on process compatibility, yield enhancement, reliability and product lifetime and shared it with industry and universities through on-site seminars and short courses. Such data is normally company proprietary in the IC industry, which hampers implementation of new technologies.

3. Sandia provided an environment to foster industry efforts in this field and to stimulate further development by organizing and hosting a series of annual workshops attended by scientists and engineers from more than 50 companies worldwide. The conference proceedings contain more than 75% of the work published in this field, and have proved to be the best selling technical volume the publisher has ever had.

4. Sandia worked to open a dialog between deposition equipment manufacturers and IC process engineers to develop design configurations which best utilized demonstrated processes thus shortening the lead time normally required to optimize system performance and get a new technique into production.

Tungsten technology is now moving ahead rapidly in this country, in Europe, and especially in Japan. The proportion of papers on tungsten in the metallization sessions of major national conferences now exceeds 80% while it was below 10% when the First Workshop of Tunsten and Other Refractory Metals for VLSI Applications was organized. Selective CVD tungsten is considered to be the best choice to achieve needed planarization at contact windows and at interlevel vias in submicron IC designs and is the only technology among other new and possibly promising possibilities for which the necessary technology base has been established and documented.

DOE - Sandia National Laboratories

UTILITY DEMAND-SIDE RESOURCES

Staff members of LBL's Applied Science Division, as part of the DOE Least-Cost Planning Program, participated in several national and regional conferences on demand-side resources and integrated utility planning, involving hundreds of utility planners and regulatory agencies. They regularly exchange information via electronic mail with demand-side planners in the state PUC's. In July 1987, LBL presented a one-day lab tour and series of briefings on demand-side research for 30 PUC commissioners and staff attending the National Association of Regulatory Utility Commissioners (NARUC) conference.

DOE - Lawrence Berkeley Laboratory

ENERGY-EFFICIENT REFRIGERATORS

An LBL organized workshop was held in New York for U.S. and Japanese manufacturers and researchers on the results of an LBL project to compare U.S. and Japanese test procedures and results for energy efficiency of refrigerators. These results were also presented at an ASHRAE meeting in June 9187. Follow-up activities may include some revision of test procedures and data, as well as further comparisons of laboratory and field performance.

DOE - Lawrence Berkeley Laboratory

SECTION C

LICENSING

SIMPLE TEST FOR SICKLE-CELL ANEMIA DEVELOPED

THE TECHNOLOGY

Sickle cell anemia is a hereditary, sometimes life-threatening disease in which red blood cells manufacture a different kind of hemoglobin called Hb-S. LLNL biomedical scientists have developed a new line of cells which secrete monoclonal antibodies that are highly specific to Hb-S molecules. The cell lines, a fusion of tumor cells with antibody-producing cells, grow forever in culture, providing consistent, high quality antibodies. These antibodies are the key to an easy way to identify carriers of Hb-S.

TECHNOLOGY RECIPIENTS

LLNL has granted a non-exclusive license to a biotechnology firm to commercialize products made from these biological materials. The firm intends to introduce a simple kit for diagnosing sickle-cell anemia. Marketing of the kit started fall of 1987.

COMMERCIAL USES AND BENEFITS

The LLNL-developed cell lines make possible sickle cell anemia testing that is much simpler, faster, and cheaper than present methods. A medical lab is not necessary to perform the test, making possible testing "in the field" from just a pinprick of blood. This holds great promise for Third World countries where sickle cell anemia is a significant health problem.

Although another quick test is available, it is not specific enough to detract Hb-S molecules in newborns and young infants. The LLNL monoclonal antibodies react to Hb-S only, leaving no doubts about test results identifying newborn and young infant carriers of sickle cell anemia. The antibodies allow a determination to be made in about 15 minutes.

DOE - Lawrence Livermore National Laboratory

SOFTWARE PERMITS DIFFERENT COMPUTERS TO "TALK" TO EACH OTHER

THE TECHNOLOGY

Computer scientists from Livermore's Technology Information Systems have developed a way for computers from different manufacturers to "talk" to each other. The Intelligent Gateway Processor (IGP) is a complex software program with about 166,000 lines of code designed to run on the popular UNIX operating environment. IGP consists of three main modules _ electronic mail, network access and integrated information system. The electronic mail function allows messages to be sent to and from computers around the world, using either telephone lines or the U.S. Defense Data Network. The network access module allows one computer to access the resources of another without the user needing to know anything about the other system. The integrated information system module gives the computer user a choice of various computer services, such as performing an electronic information search.

Hundreds of scientists have used this facility for research they would be able to do in few other laboratories. Since 1979 more than 2,000 samples have been tested. These experiments were done by investigators from 16 national laboratories throughout the U.S., as well as from universities and industry. Researchers have used the facility to study: the mechanical and physical properties of metals; the optical properties of laser glass; the properties of superconductors needed to contain the fuel in the Laboratory's Magnetic Mirror device; the properties of insulators; and the effects of radiation on organic samples, such as human liver enzymes.

Many experiments, although identified as being conducted by a single country, were actually planned and conducted to meet joint research objectives. All results from this cooperative activity are published in English in literature available to the public.

User Participation in the RTNS-II

	FY80	FY81	FY82	FY83	FY84	FY85	FY86
Estimated use ratio			(Percent of capacity)				
University	10	10	35	35	35	35	60
Industrial	60	60	40	40	40	40	20
Others	--	--	--	--	--	--	--
Laboratory	30	30	25	25	25	25	20
Total operating cost ($ in millions)	1.7	1.9	2.8	3.7	3.9	3.6	3.2

DOE - Lawrence Livermore National Laboratory

SARISA (SURFACE ANALYSIS BY RESONANCE IONIZATION OF SPUTTERED ATOMS)

THE TECHNOLOGY

When material surfaces are bombarded with energetic ion beams, the result is the ejection, or sputtering, of atoms from the surface. The behavior of these sputtered atoms tells materials researchers about impurities at the surface and in subsurface layers. Widely used current techniques can detect certain elements to a highly sensitive level. But even the best instruments, which can detect impurities of 200 parts per billion, are limited in certain respects. They detect only a small fraction of the sputtered flux, and it is difficult to quantitatively determine the concentrations of individual impurities in multicomponent systems. Additionally, the already low number of secondary ions reaching the detector is reduced significantly, decreasing the sensitivity of the instrument.

Argonne's scientists have combined sputtering with lasers to convert the sputtered neutral surface atoms to ions, and have employed a unique new time-of-flight mass spectrometer to detect the resonantly ionized atoms. The resulting system is called SARISA--Surface Analysis by Resonance Ionization of Sputtered Atoms. SARISA's design emphasizes efficient sample use, and in its difficult benchmark test--iron impurities in silicon--it detected impurities of 500 parts per trillion.

TECHNOLOGY RECIPIENTS

The licensing negotiations now underway for SARISA could have taken place much earlier had a marketing survey been conducted early on. Most of last year was spent in negotiations with a different company, only to find that it lacked the technical resources to proceed with the project. In retrospect, ARCH and Argonne believed that a marketing survey to target appropriate prospective licensees could have resulted in much earlier licensing of this excellent technology. Responding to this thought, ARCH engaged Coopers and Lybrand to conduct a survey of potential licensees. Seven companies were researched and visited and finally placed in a priority order. The company in the #1 position has visited Argonne for detailed discussions and is developing its position on licensing SARISA (Surface Analysis by Resonance Ionization of Sputtered Atoms).

Argonne has implemented a program to use MBA students from the University of Chicago Graduate of Business to conduct such studies for future licensing efforts, and expects that the program will provide good results.

USES AND BENEFITS

SARISA detects impurities in parts per trillion, a level of sensitivity about 100 times greater than existing systems. Such capability will be important in many areas of basic research, as well as technologically importatant applications such as semiconductors.

DOE - Argonne National Laboratory

MORE ACCURATE AND RELIABLE URANIUM BIOASSAYS

THE TECHNOLOGY

Through the integration of advanced laser concepts and computers, scientists at PNL developed a method for measuring uranium concentrations in bioassays more quickly, easily and accurately than conventional analytical methods. A high-intensity laser pulse illuminates the uranium, which absorbs the light and re-emits it at a specific wavelength. The data are fed to a computer which analyzes the information and generates the measurement results.

TECHNOLOGY RECIPIENTS

The kinetic phosphorimetry technology was selected for transfer in 1983. Information was prepared, disseminated to interested manufacturers and presented at an analytical chemistry conference. A prototype was demonstrated to vendors of similar equipment at a bioassay conference. Through these efforts three interested companies were identified. One of the firms capable of manufacturing the instrument and conducting bioassay analysis routinely was provided seminars, drawings and software related to the technology. Unfortunately, the corporate headquarters ultimately decided not to manufacture the instrument.

After reevaluation, a new plan was developed. PNL began working with a staff member of the previously selected firm to establish a new local company, Chemchek Instrument, Inc., to manufacture and market the bioassay device. DOE was granted a patent in July 1986 and subsequently issued Chemchek a license to use the kinetic phosphorimetry technology. With initial assistance from PNL staff, Chemchek is now manufacturing and marketing an accurate instrument. Assistance included technical support, evaluation of the first commercial instrument in mid-1986, guidance regarding the use of federal technology and support in the creation of a new firm.

USES AND BENEFITS

All workers potentially exposed to uranium through mining, milling, and processing efforts are required to have uranium bioassays routinely. The new commercial uranium analysis technique is ten times more accurate and reliable than current methods and can be done more quickly and with smaller samples; thus the cost of analysis and probability of error in sampling and analysis are greatly reduced. In addition, the results can meet more stringent regulatory guidelines expected in the future. The second transfer attempt was successful and resulted in a new small business because of the persistent and dedicated efforts of PNL staff to help move the technology to the marketplace. The first commercial sales occurred four years after the invention disclosure because scientific developments were close to those needed for commercial applications.

DOE - Pacific Northwest Laboratory

IMPROVED MONITORING OF GROUNDWATER

THE TECHNOLOGY

An innovative and inexpensive pump developed at PNL for use on government programs improves the monitoring of groundwater for contaminants. Because of a significantly lower cost than previous pumps and special design characteristics, a pump can be dedicated to each well, eliminating the need for removal and cleaning between samples and improving the quality of sampling. The pump provides a greater volume per minute than existing pumps, reduces sampling time significantly and provides samples more representative of the aquifer water.

TECHNOLOGY RECIPIENTS

Based on Battelle Development Corporation research into methods to improve the patentability of the pump technology and approaches to commercialization, a joint venture agreement was signed with a manufacturer of high-quality pumps. Shortly after agreement, interest in the pump was lost for reasons unrelated to the technology. Options for transferring the pump technology were reevaluated and a small firm, Instrumentation Northwest, Inc. was issued a license for the use of the sampling system, pump and technical information to sample and test groundwater in the United States and Canada. Additional developmental work was conducted, prototypes built for calibration tests and pump characteristics determined with PNL assistance. A small- diameter, low-cost pump is now being marketed for groundwater sampling as "HydroStar." The pump is easy to install and service, can be disassembled without special tools or skills, is durable and can be manually or automatically operated.

USES AND BENEFITS

Protecting and monitoring underground water resources has become increasingly important and expensive. In addition to drinking water, 44 percent of irrigation water is drawn from groundwater wells. As a result, operations such as industrial plants, landfills, and hazardous waste sites require continual groundwater inspections. Government regulations require that at least four groundwater monitoring wells be drilled at each potentially hazardous waste site. Organizations required to establish the quality of the groundwater and determine whether site operations are conducted within federal and safety regulations can benefit significantly from the faster, less expensive dedicated pump and the monitoring system's ability to obtain samples more typical of the water in the aquifer. Three years after the concepts were reported, products and services are being marketed by the private sector. The rapid transfer was possible because there was a well-recognized need, a market that was ready for an improved product and the advanced state of development and field testing that had occurred prior to transfer.

DOE - Pacific Northwest Laboratory

CONTROLLING ROOT GROWTH

THE TECHNOLOGY

Controlled-release chemical technology has been applied to limiting unwanted tree and plant root penetration of erosion control plants growing on uranium mill tailings piles. The biobarrier establishes a zone that prevents growth of plant roots for up to 125 years while permitting the natural growth of vegetation above the zone. The application is based on incorporation of a chemical herbicide, trifluoralin, in a polymer in such a way that the chemical release rate is controlled.

TECHNOLOGY RECIPIENTS

Disclosure of the approach to stop roots from penetrating clay, asphalt, or plastic/synthetic polymeric caps or liners that are used to line/cover buried radioactive waste disposal sites was made in 1979. As part of a planned technology transfer effort, dozens of industrial firms were contacted that potentially would be interested in commercializing the technology. Eventually the approach focused on firms interested in specific uses.

USES AND BENEFITS

To date, three companies have been issued licenses for biobarrier technology. Mantaline Corporation was issued a license in 1985 and has completed development and testing for a polymer-herbicide sewer gasket. The gasket is expected to prevent root penetration of sewer pipes for 25-50 years and save home owners and municipalities millions of dollars annually in repair and replacement costs.

Du Pont/Reemay received an exclusive worldwide license in 1986 to apply the technology in manufacturing fabrics designed to control plant and root growth under sidewalks, in highway expansion joints, in septic drain fields, under building foundations and near buried gas lines. These netting or geotextile products have an active life of 5 to 100 years and are expected to save millions of dollars annually in maintenance costs.

AGRIFIM Irrigation International received an exclusive worldwide license in 1986 for technology that will prevent roots from clogging water emitters on buried irrigation lines. Use of this technology for drip irrigation could save farmers millions of dollars each year through reduced pumping and water consumption.

The technology was developed because scientists working in two unrelated areas, waste disposal and controlled release intercervical devices, worked together on a common problem. Their efforts, combined with another staff member's initiative, transfer creativity and perseverance to find firms that could use the technology, made the transfer possible. Approximately eight years elapsed between idea generation and marketable products.

DOE - Pacific Northwest Laboratory

DEVICE PROJECTS HUMAN CAPABILITIES

THE TECHNOLOGY

Potential future nuclear fuel reprocessing facilities will need an operator controlled "telerobotic" device to perform tasks as guided by its human operator. Oak Ridge National Laboratory's Fuel Recycle Division, under the Department of Energy's national Consolidated Fuel Reprocessing Program, has designed the Advanced Servomanipulator (ASM) for use in environments too dangerous or inaccessible for direct human entry. ASM is a state-of-the-art master-slave manipulator system. The two-armed, gear-driven ASM consists of a pair of shoulder, elbow, wrist and gripper assemblies configured in an elbow-down, human-like stance. ASM incorpoirates important recent advances in control system software and modular engineering design. ASM mimics the motions of the operator's arms and hands to repair or replace failed motors, piping and other components. One of its key features is a fully modular design that allows one manipulator to be repaired in place by another, simply by replacement of an individual module or component.

TECHNOLOGY RECIPIENTS

Martin Marietta Energy Systems, Inc., which manages ORNL for the Department of Energy, has signed an exclusive license agreement with the Remote Technology Corporation (REMOTEC) of Oak Ridge for commercialization of the ASM. A part of this transfer of technology to the private sector is a four-year cooperative agreement, under which REMOTEC and DOE jointly will fund continuing activities needed to produce a commercial version of the ASM.

COMMERCIAL USES AND BENEFITS

The technology would be adaptable for work in environments too dangerous or inaccessible for direct human entry--space station construction or satellite repair, deep sea or deep underground exploration and maintenance, nuclear or chemical waste handling, and operations involving toxic chemicals, explosives and other hazardous materials.

DOE - Oak Ridge National Laboratory

SAFER METHOD OF DIAGNOSING HEART DEFECTS

THE TECHNOLOGY

A new radionuclide delivery system has been developed at ORNL for the bedside injection of small amounts of a radioactive material directly into the blood system for the diagnosis of heart function and other nuclear medicine applications. The device produces a short-lived radioisotope, iridium-191m, for use as an imaging agent to detect blood volume and flow. The device is more efficient than existing generators and lasts longer, while limiting patient radiation exposure.

TECHNOLOGY RECIPIENTS

The bedside radionuclide generator has been made available for licensing by Martin Marietta Energy Systems, Inc., which manages ORNL for the Department of Energy.

COMMERCIAL USES AND BENEFITS

As many as 20,000 of the estimated 1000,000 children born in the United States each year with congenital heart defects could benefit from the new iridium generator. Iridium-191m is particularly well suited for evaluating intracardiac shunts (abnormal holes between heart chambers) in children. It has a half-life of about 4 seconds. This allows new studies every 2 minutes or continuously by direct infusion into the blook stream. The new generator allows repeat studies to be made rapdily with extremely low radiation exposures to patients and hospital personnel. Iridium-191 could replace some of the currently available radipharmaceuticals used in more than 500,000 patients annually in the U.S.

DOE - Oak Ridge National Laboratory

"GRIPPER" USED IN CERAMICS TESTING

THE TECHNOLOGY

Little or no accurate data exist on the tensile fatigue properties of advanced structural ceramics. Such data is vital to potential uses of toughened ceramics in advanced heat engines and other applications that require the ability to withstand severe operating stresses. Conventional custom-made tensile testing devices are expensive, difficult to operate, require special specimen preparation, and frequently bend and damage specimens during testing. Kenneth C. Liu, research staff member in ORNL's Metals and Ceramics Division, developed a self-aligning grip assembly, the first accurate and economical gripping device for measuring the tensile strength of advanced ceramics.

TECHNOLOGY RECIPIENT

Martin Marietta Energy Systems, Inc., which operates ORNL for the U.S. Department of Energy, has licensed the device for commercial applicaiton to the Instron Corporation, Canton, Mass. Instron refers to the device as the "Supergrip"

COMMERCIAL USES AND BENEFITS

The self-aligning grip assembly provides extremely accurate specimen alighment and requires no special operator training or specimen preparation. Eight interconnected hydraulic pistons uniformly distribute a tensile laod through the center of a test sample. The device can be water cooled easily to make it compatible with induction heating or small furnaces which permit higher-temperature testing of ceramic samples. Instron is a leading producer of instruments and systems used worldwide for advanced materials testing.

DOE - Oak Ridge National Laboratory

ALLOY GETS STRONGER AS IT GETS HOTTER

THE TECHNOLOGY

Nickel aluminides ($Ni3Al$ and its derivatives containing chromium) are a new class of alloys with the unique combination of high temperature properties and corrosion resistance. ORNL materials scientists have invented nickel aluminides which have increased ductility because of small additions of boron andd increased strength because of small additions of zirconium and hafnium. Because of their high aluminum content, these alloys are 10 to 20 percent lower in density than most commercial nickel-based superalloys. Nickel aluminide is six times as strong as stainless steel at 600 degrees C (1,100 F). With a composition based largely on raw materials available in North America, it is an attractive alternative to high-temperature alloys that depend on foreign-supplied cobalt or chromium.

TECHNOLOGY RECIPIENTS

The first technology transfer license agreement signed by Martin Marietta Energy Systems after it became managing contractor of the Department of Energy's facilities in Oak Ridge, TN, and Paducah, KY, was with Cummins Engine Co., in September 1985, for the use of nickel aluminide in large diesel engines. One of the most recent license agreements, signed in December 1987, was with Armco, Inc., one of the five largest steelmakers in the United States. Armco's nonexclusive license authorizies it to produce and sell the alloy. The rights acquired by Armco exclude applications of nickel aluminide which have been licensed earlier on an exclusive field-of-use basis.

COMMERCIAL USES AND BENEFITS

Nickel aluminide's unusual properties of increased strength and ductility at high temperatures make this alloy interesting to several different types of manufactures. Armada Corp. has acquired exclusive field of use rights to the Material for commercial use in electric resistance heating elements. Other potential applications include high-performance jet engines, gas turbines, advanced heat engines, heat exchangers in nuclear and coal-fired steam plants, and dies an dmolds for forging, forming and casting at high temperatures.

DOE - Oak Ridge National Laboratory

"WHISKER-REINFORCED" CERAMIC STRONGER, MORE RESISTANT

THE TECHNOLOGY

The addition of rod-like silicon-carbide "whiskers"--fibers less than 200 millionths of an inch in diameter--to the ceramic matrix results in a reinforced composite which exhibits dramatically improved strength and wear resistance. The embedded whiskers, produced from rice husks, serve to deflect the growth of potentially destructive cracks in a normally brittle material, making the composite muchless prone to catastrophic failure under mechanical stress. The increased toughness extends to temperatures as high as 1,000 degrees C (1,835 F).

TECHNOLOGY RECIPIENTS

Martin Marietta Energy Systems, Inc., has granted licenses to six companies to develop products from advanced ceramic composite materials developed at ORNL.

COMMERCIAL USES AND BENEFITS

The hardness of the material has led to applications in cutting tools, now on the market, which can operate at 10 times the speed while lating 7 times as long as those made from conventional materials. Six companies have licenses to develop products from this particular ceramic material. In addition to cutting and wear-resistant applications, other possible uses of the whisker-reinforced ceramic composite include high-temperature engine components, energy-saving industrial heat recuperators, and pump seals in petrochemical plants.

DOE - Oak Ridge National Laboratory

COMPACT HELIUM-DILUTION REFRIGERATOR

THE TECHNOLOGY

Continuous-operation helium-dilution refrigerators have been used for many years to provide ultra-cold temperatures for research. But available units required specialized knowledge to operate and maintain, on-site construction and debugging, and considerable space, and cost more than $100,000. Consequently, their use was limited primarily to physics laboratories, and the only known manufacturer was in Great Britain.

Argonne National Laboratory developed a compact helium-dilution refrigerator that is inherently reliable, quiet, and simple in design and operation. Helium is not pumped continuously back to a mixing chamber, as in the continuous-operation refrigerator, but is recycled using charcoal absorbers. This means several advantages that include quiet, vibration-free operation, cooling to less than 0.02 degree Kelvin, unattended recycling, simple operation, small size, and low cost. The refrigerator replaces much more complicated continuous helium-dilution refrigerators ten times its size, and is simple to operate.

The Argonne prototype has been operated at low temperature (at the Cryogenic Engineering Conference) away from a laboratory, in St. Charles, Illinois, and was displayed at the International Low Temperatures Physics Conference in Kyoto, Japan, in August 1987. This remote operation would never be attempted with standard helium-dilution refrigerators.

TECHNOLOGY RECIPIENTS

The compact helium-dilution refrigerator is expected to open up new markets worldwide, for both civilian and military applications. The refrigerator's developers at Argonne have completed computerized controls that simplify operator interactions and automate recycling.

A license to manufacture the helium-dilution refrigerator was signed on June 26, 1987, by RMC Corporation of Tucson, Arizona, and the ARCH Development Corporation. RMC has begun taking orders, and plans to exhibit a prototype of the helium-dilution refrigerator at the March 1988 meeting of the American Physical Society.

USES AND BENEFITS

Continuous cooling clearly has a place for large continuous heat loads. But the new refrigerator fills a much greater need--for simplicity, ease of use, and reliability. Because so many maintenance and operational problems are eliminated by the new design, it is more suitable for most users, who cannot afford to maintain a staff of experts to keep a complicated system operable.

A factor in the successful commercialization of this technology was $50,000 of Department of Energy "seed money" that the inventors used to computerize the refrigerator system controls, simplifying operator interaction and allowing automated recycling. The refrigerator's simplicity and ease of use are significant features, making it more widely marketable.

DOE - Argonne National Laboratory

SECTION D

INDUSTRY SPONSORED RESEARCH

"WORK FOR OTHERS" CAN STRETCH CORPORATE R&D DOLLARS

THE TECHNOLOGY

"Work for Others" (entities other than the U.S. Department of Energy) makes up a substantial part of the research and development carried out at Argonne, and is one of the most significant ways in which Argonne transfers its technology to the private sector. Industry can contract with Argonne to solve a specific technical problem or to help develop a complex technology where Argonne has unique expertise or facilities (Argonne must not compete for work that can be performed by non-government organizations). The opportunities for working with Argonne include cooperative research and technical consultation.

Intellectual property rights are an important consideration in Work for Others. Work at Argonne that is funded wholly by a private company carries with it the right to any intellectual property rights that may result from that work unless there is significant ongoing federallyt funded work on the same topic, when DOE retains the rights.

The kinds of problems Argonne is helping industry to solve reach across many industries. For example, this year alone, Argonne is working on flow-induced vibration, dessicant characterization, magnetic depth profiling, battery/fuel cell development, electromagnetic casting, anemometer response, the mechanics of frying processes, transportation modeling, toxic materials and wastes, electrophoretic analysis, health risk estimates, thermal-hydraulic analysis, emergency preparedness, and fluidized-bed coal combustion. The scope of work ranges from standard chemical analyses to development of an innovative solid oxide fuel cell aimed at commercialization.

Some of these projects have resulted from informal discussions about a particular problem a company was experiencing. Creative solutions often are what is needed, and such solutions may not appear on a list of available resources. Companies with a need that falls into any of Argonne's program ares are encouraged to call and talk things over to learn whether an Argonne Work for Others project is just what is needed.

TECHNOLOGY RECIPIENTS

Industry.

USES AND BENEFITS

Work for Others offers industry an opportunity to use research facilities and expertise that might not otherwise be available. In this way, companies can effectively increase their R&D budgets. An important aspect is the access to intellectual property rights resulting from such work.

DOE - Argonne National Laboratory

PROPERTY CONTROL WITH ION-GUARD

THE TECHNOLOGY

Ion-Guard, a security paint developed at PNL to mark government property for identification, is now available commercially. The paint contains an indelible, traceable, tamper-resistant chemical code that bonds with metal, plastic, rubber, canvas, fabric, and ceramic. It can be brushed, sprayed, dipped, or applied as stickum on labels and decals. Marks made with Ion-Guard are normally visible and can be detected by ultraviolet light and x-ray fluorescence. The property can still be identified even after attempts have been made to eradicate the Ion-Guard marks.

TECHNOLOGY RECIPIENTS

After developing the paint in 1977 and using it to control government property, Battelle, which operates the PNL for DOE, funded a 1980 field test evaluation and small-scale industrial market survey of the security paint. The Battelle Development Corporation (BDC) reviewed the concept for marketability and established a two-year venture, Ventec Corporation, in October 1981 to start producing, marketing, and selling the paint under the name Ion-Guard. The venture included computerizing the process of mixing the paint and recording the unique codes and their uses. In March 1982, prototype kits were sold for industrial end-user evaluation. A home kit was available one year later.

By January 1984, the venture assets had been sold and inventories transferred to Chem-Guard, Inc. Battelle supported the new company's startup until March 1984. The company continued the innovative process and applied the technology to other uses. Four years after purchase, sales are growing as companies adopt the technology, and distribution is expanding into foreign markets.

USES AND BENEFITS

The Ion-Guard technology was developed for a specific problem that had a direct analogy in the commercial sector. Technical development was completed prior to transfer to the private sector. Process development and initial marketing and distribution were accomplished by a new venture whose assets ultimately transferred to one of the original distributors. The distributor was familiar with the product, its uses and potential markets and was able to start a small business based on the Ion-Guard technology and process.

There was no patent involved with the technology. The main advantages to the new venture firm and the small business were the technical know-how and access to further research and development by the concept originators. The value added by the new venture, which automated the process and initiated production and marketing, shortened the commercialization startup. Seven years after the idea had been conceived, a new business had been established.

DOE - Pacific Northwest Laboratory

SECTION E

TECHNICAL CONSULTATION

PERL TECHNOLOGY HELPING MACHINE TOOL INDUSTRY

THE TECHNOLOGY

PERL (Precision Engineering Research Lathe) is a highly advanced diamond turning machine. It was designed by LLNL Precision Engineering Program (PEP) specialists as a research tool for obtaining a better understanding of the cutting process. The design team received the prestigious IR-100 award in 1987. PERL's significant advances include:

- Two linear slides supported by 10 centimeter-travel hydrostatic bearings developed at LLNL.
- Capstan drives for smooth slide motion.
- A brushless dc torque motor to minimize errant spindle motion.
- Laser interferometers for precision position feedback.

TECHNOLOGY RECIPIENTS

PEP researchers are helping American machine tool builders incorporate much of PERL's technology in a new generation of diamond turning machines. Many of the features that were developed for past generations of LLNL diamond turning machines are now standard in commercial equipment.

USES AND BENEFITS

Diamond turning machines represent true "state of the art" machine technology. They achieve previously unheard of accuracies for machine tools - millionths of an inch. These machines use a diamond tool that moves slowly across the face of a part in order to remove small amounts of surface material and thus leave behind a mirror-like finish. They incorporate stable mechanical assemblies, sophisticated computers and extremely rigid temperature controls. The machines are producing an increasing array of products like guidance, laser and optics parts, molds for plastic lenses, computer memory disks and photocopier cylinders. LLNL diamond machine tool technology is helping American tool builders compete with their European and Japanese counterparts.

DOE - Lawrence Livermore National Laboratory

CALIBRATION SYSTEM MAKES BETTER SOLAR MEASUREMENTS

THE TECHNOLOGY

In their efforts to capture the sun's radiant energy and convert it to electricity, researchers must deal with constantly changing outdoor conditions. Time of year, time of day, location, ground reflection, and the amount of haze and water vapor in the atmosphere all can affect the radiant energy striking a photovoltaic(solar)cell. When researchers test a cell outdoors, they must be able to correct for these conditions to produce consistent test results.

To help make these corrections, scientists at the Solar Energy Research Institute (SERI) are developing a system that provides accurate, on-the-spot measurement of the atmosphere's optical properties. This atmospheric optical calibration system (AOCS) consists of easy-to-use, readily available instruments, microprocessors, and a computer model that calculates the actual solar spectrum.

Instruments in the AOCS measure parameters such as air pressure, direct normal solar riddance at selected wavelengths, direct normal flux density, and radiant energy striking a horizontal surface. These data are fed into a computer program that calculates the actual solar spectrum. Researchers then can compare the measured atmospheric conditions to the test device. The AOCS also warns researchers when atmospheric and spectral conditions are too far from standard to correct so that the test can be postponed.

TECHNOLOGY RECIPIENTS

The AOCS has potential commercial value beyond the photovoltaics community. For example, the system's low cost and mobility could make it attractive to atmospheric and environmental scientists for many different purposes--for example, to determine air quality or to monitor climate changes. Midwest Research Institute Ventures (in conjunction with SERI) is currently exploring the possibility of licensing this technology to the private sector, such as optical instrumentation companies.

USES AND BENEFITS

The real-time analysis of atmospheric optical conditions is a significant improvement over conventional methods. Since the AOCS is easily transportable, it is useful in a wide variety of geographical locations. In addition, off-the-shelf components allow the system to be configured at a reasonable expense.

DOE - Solar Energy Research Institute

NASA SAVES CANDY

THE TECHNOLOGY

Heat pipe technology, which has been used extensively in space, has sweetened the energy diet of a candy manufacturer in Albany, Georgia, Bobs Candies, the world's largest producer of candy canes, must produce the confections year-round to meet Christmas demand. The crisp, white, brightly striped canes must be stored at controlled temperature and humidity levels to retain product freshness. To reduce humidity, the company's warehouse air conditioners consume huge amounts of energy to "super cool" air to remove moisture and then reheat it to acceptable temperature. For four years, Mukesh Khattar of the Florida Solar Energy Center has been adapting heat pipes for air-conditioning systems to efficiently increase their moisture removal capabilities.

TECHNOLOGY RECIPIENTS

When Don Bravaldo, Bobs Candies VP, learned about Khattar's work under a technology transfer contract with NASA's Kennedy Space Center, Florida, he enlisted NASA's help to apply the technology. Georgia Power Company, which supplies energy to the candy manufacturer, joined the project to support this energy-saving effort and to learn more about this new technology.

A candy warehouse in Albany was selected to demonstrate the technology. The warehouse is used only during the summer months, and the air-conditioning equipment's energy consumption levels for the past four years were known. Existing system performance was monitored before retrofit. The heat pipes were installed in early 1987, and the results were phenomenal:

- In June 1987, the system used only 38,960 kWh at a cost of #3,312 compared to 152,160 kWh at $8,667 in June of 1985. That totals 74% in energy savings and 62% in dollar savings.
- The July 1987 results were even sweeter. The system used only 19,120 kWh costing $1,797, compared to 154,440 kWh at $8,683 in July of 1985. That represents 88% in energy savings and 79% in dollar savings.

USES AND BENEFITS

The demonstration showed additional benefits: use of heat pipes increased the system's moisture removal capacity. Previously the warehouse had two 30 ton air-conditioning systems to meet space conditioning needs. Only one of the two units was retrofitted with heat pipes and it alone is now sufficient to maintain indoor conditions. In addition, indoor humidity levels are generally lower than in previous years.

There are numerous applications where the use of this technology can greatly reduce energy expense. Examples include any situation where reheating is used for humidity controlled manufacturing and storage of drugs, chemicals, paper, chocolate and electronic components; drying of film, food products and lumber; and air conditioning of museums, auditoriums, grocery stores, hospitals and clean rooms.

NASA - Kennedy Space Center

NEW INDUSTRIAL WASTEWATER TREATMENT SYSTEM REAPS SAVINGS

THE TECHNOLOGY

The Air Force Engineering and Services Center (AFESC) has the responsibility for environmental quality research and development. AFESC works closely with Air Force operational commands to pioneer technologies to solve existing environmental problems and avoid any environmental consequences of new weapons systems by developing state-of-the-art hazardous waste treatment processes. AFESC is conducting research on a method to reduce hexavalent chromium with sulfide in the presence of the ferrous ion has been reported at alkaline pH with less sludge production than the conventional acidic sulfur dioxide/lime treatment process. AFESC conducted a program to determine the feasibility of using this process to decrease sludge production, and chemical usage at Tinker Air Force Base (AFB). Phase I, bench scale testing, showed that a sodium sulfide/ferrous sulfate (S/Fe) treatment method for reduced hexavalent chromium and removed heavy metals from electroplating and industrial wastewater through clarifier operation. The results also suggested that this S/Fe process would significantly decrease sludge generated and hence, wastewater treatment costs. Phase II, pilot plant field verification studies were conducted to evaluate and optimize the chemical and physical parameters of the S/Fe process, the precipitation and clarification process, and the activated sludge system. Sludge production and chemical usage of this process was evaluated and compared to the sulfuric acid/sulfur dioxide/lime process. Additional testing was conducted to determine the effects of orthophosphate, ethylenediaminetetraacetic acid, cyanide, additional metals, flow rate and temperature on chromium reduction, metal removal, and the activated sludge system. The impact of a procedure for switchover to the sodium sulfide/ferrous sulfate process was also investigated.

TECHNOLOGY RECIPIENTS

Based on the results of Phase II, a full-scale production system is being implemented at Tinker AFB, for a 1.2 million gallon per day wastewater system. It will be operational in June 1988, and is expected to provide yearly savings of $600,000 by reducing chemical usage and hazardous sludge production. Rapid technology transfer from Tinker AFB to other Air Force Commands, to DOD, and then to the private sector is expected since the process is applicable to most industrial wastewater treatment facilities.

USES AND BENEFITS

The S/Fe system can be used to treat most industrial wastewaters for reduction of chromium and precipitation of heavy metals. There is great potential savings due to reduced chemical usage and sludge reduction for conversion of a conventional treatment system to the S/Fe process. Conversion costs should be recoverable, in most cases, in less than a year. The savings at Tinker AFB are expected to be around $600,000 per year, with conversion costs for the state-of-the-art system at around $320,000. Large potential savings with reduced environmental liability will result. Also, with further research and development, there is a potential for metals recovery and rinsewater recycle for individual industrial processes.

DOD - Air Force Engineering & Services Center

MEASUREMENT TECHNOLOGY FOR RADIATION PROCESSING

THE TECHNOLOGY

Measurement of ionizing radiation by recording the change in color of certain chemicals is one of the most stable, reliable and inexpensive methods now available. The technology, developed jointly by NBS and collaborators in the Army and Federal Emergency Management Agency, has been expanded to provide improved accuracy and dose measurement range. More than 600 radiation sources are in use today to sterilize medical products, delay food spoilage, vulcanize rubber, scrub liquid and gas effluent, treat industrial waste such as PCP, process wire and cable insulation, graft polymers, produce heat shrinkable food wraps, sound insulation, tanning of hides and many other usages. Radiochromic dye dosimetry is finding widespread acceptance as the technology of choice in almost all of these facilities.

Non-colormetric methods supplement this system. A new potassium dichromate dosimeter, and a new graphite calorimeter have been developed to provide accurate calibration of radiation processing beams under conditions previously hard to tie into National standards.

NBS has shared its emerging stream of new developments in this field with industry through conferences, publications, patents, research associates and intensive consultation with industries. Products based on this technology are produced by a small California firm, Far West Technology, Inc. and in a new form by GAF Corporation. William McLaughlin, leader of the NBS effort was recently honored by receiving the Radiation Science and Technology Award from the American Nuclear Society for his work in Industrial Radiation Measurements. Five guest workers spent time at NBS collaborating on this research and collaborative work estimated at $650,000 value lent strength to this program.

TECHNOLOGY RECIPIENTS

More than 60 industries, universities and government organizations consulted NBS scientists on applications for this technology in the last year.

USES AND BENEFITS

The measurement system is in commercial production and is serving many of the 460 accelerators now used by the U.S. radiation processing industry.

DOC - National Bureau of Standards

SURFACE SCIENCE ENHANCES PRODUCT QUALITY

THE TECHNOLOGY

Surface science is traditionally regarded as a pursuit of basic knowledge through the use of thin layers or small samples, with few applications to actual problem solving. However, PNL scientists recognized the value of this discipline in revealing conditions affecting material performance as well as its importance in manufacturing processes. Using surface science as a trouble-shooting technique, PNL scientists are helping companies, especially smaller ones, solve materials-related industrial problems in areas as old as metal corrosion and as new as the modern integrated circuit chip.

TECHNOLOGY RECIPIENTS

In one project for a small business manufacturer, PNL identified a material that was causing pitting corrosion of the product. Through PNL efforts, the firm was able to take corrective action and meet a delivery deadline for a $1-million order for its product. PNL has also used surface science research to:

- determine that residue film was hindering product fabrication
- identify materials with improved fracture characteristics for product improvements
- reduce production of unusable wood products caused by problems with a binder
- assist in the development of a uranium reactor fuel product
- determine the cause of solder-joining problems occurring during the fabrication of a semiconductor component
- develop improved ceramic-bonding techniques for dental products.

USES AND BENEFITS

By making sophisticated instrumentation available and providing unique information that is important for successful production processes, PNL is helping industrial firms enhance product quality and meet production schedules in a cost-effective way.

DOE - Pacific Northwest Laboratory

WIND ENERGY SITING

THE TECHNOLOGY

The DOE Wind Energy Characteristics Program was one element of the Federal Wind Energy Program which was initiated by the Energy Research and Development Administration (ERDA) and continued by DOE. PNL managed three projects which focused primarily on data related to the atmospheric fluid dynamics of wind energy. The results were made available to the public in a 500-page turbine siting handbook, a Wind Energy Resource Atlas, numerous technical reports and data tapes.

TECHNOLOGY RECIPIENTS

PNL awarded more than 125 subcontracts for applied research to universities, consultants and industrial concerns, acted as liaison with other elements of the Federal Wind Energy Program and transferred technical information to users and the public. Direct industry participation involved firms that manufactured meteorological instruments, provided meteorological consulting services, or offered R&D services in atmospheric sciences. Indirect industry participation took the form of information exchanges with wind turbine manufacturers.

PNL researchers also assessed the worldwide geographic distribution of wind energy. At the request of the World Meteorological Organization, DOE results were plotted on a poster-size map. Subsequently, 3,000 copies of the map were distributed at a United Nations conference on New and Renewable Sources of Energy.

The information and data has provided a basis for considerable industry effort. Small wind turbine manufacturers and distributors have used the program handbook to site small wind turbines and improve the reliability of site selection. Utilities and companies formed to generate and sell power to utilities have used the large wind turbine siting document to screen potential sites within specific service regions.

USES AND BENEFITS

To date, the most widely used documents are the U.S. regional wind energy resource atlases. These provide information for market surveys, economic analyses and feasibility studies of wind energy in selected areas of the country. Large wind turbine designers have used technical reports and data to improve the design and performance of large wind turbines. Several companies have diversified their businesses to include wind characteristic measurements and offer this service based on experience gained through the program.

The availability of realistic wind data and analyses has contributed significantly to the understanding of the cost-competitive nature of wind energy relative to other electrical generation systems in the United States. In addition, the studies advanced understanding of how airborne pollutants are affected by irregular terrain.

DOE - Pacific Northwest Laboratory

SUPER SLURPER GENERATES NEW PRODUCTS AND BUSINESSES

Agricultural Research Service (ARS) scientists have provided technology transfer assistance recently to several new firms for development of new products using Super Slurper. Super Slurper is a substance that can absorb up to 1,400 times its own weight in moisture. Based upon cornstarch, Super Slurper has been used in body powders, diapers, and sanitary napkins. Newly licensed uses include fuel filters which remove water, medical cold packs, and bulk absorbents for agricultural uses. One new company which started just 18 months ago making products based on Super Slurper reported booming sales and a profitable operation within the first year.

DOA - Agricultural Research Service

METER MEASURES FAT IN HUMANS

A "fat-meter" based upon technology developed by Agricultural Research Service (ARS) scientists is being manufactured and marketed in U.S. Utilizing NIR technology and computer techniques first developed for measuring protein content in grain, it is a non-invasive, non-immersive instrument method for measuring the percentage of fat in the human body. Newer features added by the manufacturer provided a computer readout indicating whether or not the subject is overweight and if so by how much. Age, height and other factors are taken into consideration. ARS scientists have continued to provide advice and other limited assistance to the manufacturers.

DOA - Agricultural Research Service

AN ANALYSIS OF A COGENERATION SYSTEM AT TEXAS A&M UNIVERSITY

A detailed cogeneration analysis has been conducted for the campus of Texas A&M University in College Station, Texas as a part of a study to evaluate various cogeneration alternatives for Texas State agencies. The analysis used the CELCAP computer program (obtained from the Navy's Civil Engineering Laboratory). Hourly steam and electrical loads were used in order to size the cogeneration system. Other information required by CELCAP were the physical characteristics and efficiencies of the generation units and the boilers; utility rates; operation and maintenance costs of the gas turbines, steam turbines and the boilers; and a calendar of the working and non-working days throughout the year.

The CELCAP program was run with the current campus cogeneration system to determine the 1986 base case costs and to validate the campus model. An additional base model was developed using the current system and the new energy requirements for the 1990-92 time period. Five different scenarios of operation of cogeneration systems were considered to determine the optimal system/operation for the present and future demands of this campus./ A 37.4 mmw gas turbine-generator set with a waste heat boiler provided the best economics for Texas A&M. Both simple pay back and net present value (NPV) economic analyses were performed for the commended system.

DOD - Naval Civil Engineering Laboratory

ROTARY AIR STRIPPING FOR REMOVAL OF VOLATILE ORGANICS FROM GROUNDWATER

Although air stripping had already been used in removing volatile organic contaminants such as chlorinated solvents and jet fuel components from ground water, a faster method using smaller units was needed. Rotary air stripping had been used in the oil industry, but this method (also known as the HIGEE method) had never been tried for removing contaminants from ground water. The principles were the same as for the oil industry technology. The appeal of this method was its use of a rotating bed to increase the contact area between vapor and liquid, thus, increasing the mass transfer of the contaminant from one phase to the other. In turn, this would reduce the amount of packed bed depth, when compared to systems which do not use a rotating bed. A field problem was available to test this technique. The water supply at Traverse City, Michigan was contaminated with fuel components (benzene, toluene, xylenes) which were believed to originate from the fuel storage area on the Coast Guard facility. Knowing that AFESC/RDV had experienced success with air stripping at Wurtsmith AFB, Michigan, the Coast Guard requested assistance. This laboratory sponsored an effort to test a prototype system. The study demonstrated the feasibility of using Rotary Air Stripping for ground water cleanup. Some questions remain concerning cost-effectiveness compared to conventional air stripping and extension of other contaminants of interest. Follow-up evaluations will address these problems. This system can be used to remove jet fuel components and chlorinated solvents from ground water. This study has laid the groundwork for further exploration into using this or similar technology to clean up the hundreds of other contaminants that could find their way into USAF and municipal ground water supplies.

DOD - Air Force Engineering & Services Center

ALARM COMMUNICATIONS SYSTEMS

In 1984, Sandia began work on a project to develop an alarm communications system to gather and report security alarm information in a timely and reliable fashion. The intent was to develop a system that would utilize manufacturer-supported standard commercial products for all hardware components, in order to relieve Sandia of having to provide long-term technical support to facilities utilizing our technology. After several years of working with a commercial supplier, the TROS-8/4 Alarm Transponder by Stellar Systems is now available. In addition, Sandia is developing a second source for the transponders, the Vindicator Corporation. This project has been an excellent effort aimed at technology transfer.

DOE - Sandia National Laboratories

FERMILAB ADVANCED COMPUTER PROGRAM (ACP)

Fermilab has developed a multi-microprocessor "super computer" which is flexible and modular and has unique cost effectiveness for scientific problems requiring extraordinarily large amounts of computing time in a conventional high level language and operating system environment.

Computing budgets in science frequently are severely strained by scientists' requirements. Access to the most cost effective computing engines that support high level programming languages like Fortran is, therefore, of critical importance in the scientific community. Surprisingly, conventional large main frame and vector supercomputers are more than an order of magnitude behind certain of the new commercial 32 bit microprocessors in effective computing power per dollar. The Fermilab project has developed a system that allows scientists to use arrays of several hundred highly cost effective single board computers based on these microprocessors. The Fermilab ACP Multiprocessor System is modular and flexible thereby permitting a wide variety of configurations appropriate to different needs.

The group first 140-CPU ACP system has been built under the supervision of the ACP. Arrangements were made for a local company, which specializes in such products, to take over the role of mass producing modules. Omnibyte Corp. of West Chicago has delivered over 100 ACP-designed CPU's and has orders for many more, the majority from outside Fermilab. They are delivering all the interface and control modules that make up the full ACP Multiprocessor System. Systems are now running, being installed, or on order for, among others, Yake, Los Alamos National Laboratory, Montreal, Toronto, Rutgers, Antwerp, SIN (a Swiss National Lab), Saclay (a French National Lab), and Brookhaven.

DOE - Fermi National Accelerator Laboratory

SECURITY SYSTEMS

A Sandia staff member has been working the past few years on a project called SENLEX (Sensor Layout Expert),which is an expert system intended to assist security system designers in the layout of an exterior perimeter sensor field. The use of this system literally enables a designed to have the many years of experience of perimeter experts at his command. Following the development of SENLEX, our staff member spent many hours of work in order to make SENLEX user-friendly, and then spent much more time transferring technology to commercial users. To date, she has travelled to Chicago to work with Ronald E. Timm and Associates (RETA) and to Richland, WA, to meet with the staff of the Westinghouse Security Applications Center (SAC). After many long nights in Chicago, our staffer has enabled RETA to develop their understanding of SENLEX so they are now using the code for this work in the design of perimeters at several DoD installations in Europe. Present efforts are aimed at the establishment of a second center of expertise in SENLEX so that any commercial or government entity can be easily trained.

DOE - Sandia National Laboratories

WHY DON'T EAGLES OR PENGUINS NEED SUNGLASSES?

Specially designed lenses for sunglasses which are similar to the light filters in the eyes of penguins, eagles, and other high-performance birds of prey have recently been used by pilots to improve their visual acuity and safety. Designed by a former NASA scientist (Laurie Johansen) and engineer (Paul Deffendaffer), these lenses are now being acclaimed as important safety equipment for all pilots. They have recently invented another lens made specifically for use on the water. It is expected to benefit sailors, just as earlier versions aided pilots. The inventors recently filed an international patent on the new penguin-like PST lens. The products are derived from filter designs at NASA/JPL which were initially to be used in spacecraft for planetary exploration to aid in color imaging of the planets.

Eagles and penguins have many microscopic filters in their eyes that remove blue and violet light. These new sunglasses function like the microscopic filters in the bird's eye. Like these filters, the original Avian sunglasses are a brilliant orange in color - and like the droplets, they provide remarkable visual improvement. Consequently, Suntiger lenses have already gained high acclaim from pilots involved in the high tech sport of Soaring competition. They are produced by Suntiger Biomedical Optics, Sylmar, CA.

Conventional polarized and non-polarized sunglasses do not substantially block high energy radiation and were eclipsed four years ago by the safety and comfort found in the Suntiger Avian lens. But in highly reflective environments like urban areas, ski-slopes and waterside regions, the new brownish colored PST lens offers even more thorough protection. This is due to its unique ability to prevent virtually all the blue, violet and UV radiation, as well as damaging high-intensity glints, from reaching the delicate lens, cornea and retinal eye tissues.

Like the pioneering Avian lens, the state of the art PST lens increases visual acuity, reduces the visual effect of haze, and protects night vision. But more important than all of these improvements, they contribute to the prevention of the two leading causes of blindness in our society: age-related cataract, and age-related macular degeneration. Medical evidence now implicates high energy (blue, violet and ultraviolet) sunlight as a significant factor in these diseases. The U.S. Department of Health reports that cataracts affect over 3.3 million Americans annually. And according to Dr. Young of the UCLA School of Medicine, more than one in ten adults over age 64 will suffer some visual loss from macular degeneration. "Over a period of years, research evidence suggests these glasses, with their substantial safety, could have a preventative effect on the incidence of age-related blindness in the U.S.," says Dr. Michael T. Hyson, Jet Propulsion Laboratory scientist.

NASA - Jet Propulsion Laboratory

PULSE COMBUSTORS

Pulse combustors are one type of heating device that takes advantage of acoustically enhanced heat and mass transfer to achieve improved system performance. The claims of improved performance of pulse combustors over conventional furnaces is supported by observed higher thermal efficiencies, lower output emissions and reduced size. Although the principles of pulse combustor operation are well known, the interactions of the system geometry, the fuel and air intake system, the heat transfer and friction, and the role of fuel chemistry are not well understood. This lack of fundamental understanding of the nonlinear interaction of a large number of system parameters has hampered the ability of industry to scale operating laboratory-size combustors to much higher frequencies, reduced noise, and acceptable emissions levels required for future residential and industrial applications.

Over the past three years we have worked closely with representatives of industry to identify and provide the fundamental information needed to design and produce the next generation pulse combustion furnaces. Our thrust has been to develop a comprehensive model of pulse combustor dynamic behavior which can be used to predict trends in system operation to changes in design parameters. Our numerical model, which is based on the unsteady, variable-area, one-dimensional equations of continuity, momentum and energy, predicts the influences of the system geometry and operating parameters on the wave dynamics within pulse furnaces. Losses due to friction and heat transfer are also included. To validate this model we require detailed measurements of flow velocities, fuel and air mixing efficiencies, temperature profiles and emissions. We have designed and operated an experimental facility which utilizes state-of-the-art measurement techniques to obtain information essential to developing a better understanding of pulse combustion phenomena, and to provide detailed information that is critically needed for a validated detailed model of pulse combustor operation.

Our computer simulations of pulse combustor operation is the only fully coupled model currently available, and has been used extensively by Lennox Industries to aid in the design of a prototype high efficiency residential furnace for future introduction into the marketplace. We are also providing detailed calculations, upon request of Forbes Energy Engineering, to aid in their design of very large pulse furnaces (500 - 1,000 Mbtu/hr) for future industrial processing applications. Our interactions with industry have been facilitated by frequent exchanges of information with the Gas Research Institute, (GRI), an organization which promotes the efficient and clean use of natural gas resources. Through this representative of U.S. natural gas suppliers, we interact directly with a number of pulse combustor manufacturers by the sharing of our experimental measurements and modeling capabilities.

DOE - Sandia National Laboratories

POLLUTION IMPROVEMENTS

RAPRENOx is a new chemical process for eliminating an important pollutant, nitrogen oxide, from combustion exhaust products. The process can potentially play a major role in controlling NOx emissions, the major contributors to photochemical smog, from combustion devices including furnaces, boilers and engines. The process has been named RAPRENOx (rapid reduction of nitrogen oxides).

In this newly identified process, a common, nontoxic chemical already in widespread use as a chlorine stabilizer in swimming pool water is inserted into the exhaust stream, and the exhaust gases pass over it. In a series of laboratory tests on a portion of the exhaust from a small diesel engine, it has been shown to remove more than 99 percent of the nitrogen oxides present.

To date the RAPRENOx concept has been investigated only in the laboratory to test scientific feasibility. However, the technology -- including engineering research, hardware, development and performance testing -- will be carried out in the private industrial sector. In order to facilitate the process, the Department of Energy has waived its title to the invention to Mr. Perry, who has now left Sandia to form a private company to pursue commercialization. The Federal Government, however, retains the rights to use the invention, without paying any license fees. In addition, the lead engineering technician on the project, has left to join Perry's company. Technology transfer has been effected by the lead developers establishing their own venture enterprise.

If RAPRENOx successfully commercialized, it could have an important and positive effect on transportation and heavy industry by providing a practical means to meet Federal pollution guidelines.

DOE - Sandia National Laboratories

ACCELERATOR DESIGN SOFTWARE

Because of the recent interest in the utilization of synchrotron radiation sources for commercial x-ray lithography, several firms have requested - and obtained - copies of the LBL accelerator physics code ZAP. The code is useful in designing such machines and assessing their performance. In the past year, the code was sent to two Japanese firms (Ishikawajima-Harima Heavy Industries and Mitsubishi Electric Company) and to IBM in New York. In addition, the code was provided to the Synchrotron Trieste Company, a consortium of Italian business and government organizations assembled to build a synchrotron radiation source in Trieste, Italy. Several scientists from the Accelerator and Fusion Research Division visited Trieste this summer to provide instructions on the use of ZAP and to participate in the training of the staff there for the design effort that is just beginning.

DOE - Lawrence Berkeley Laboratory

NEGATIVE-ION SOURCE TECHNOLOGY

An H^- ion source using the so-called volume-production process was fabricated for the Grumman Corporation, which had requested the source in connection with SDI-related R&D activity. Transfer of this technology was based on expertise acquired during source development work for the magnetic fusion program.

DOE - Lawrence Berkeley Laboratory

VIDEO MOVIE SYSTEM FOR THE DISPLAY OF SCIENTIFIC DATA

A versatile, low cost video movie making system has been developed at the Lawrence Berkeley Laboratory for making movie-like displays of time dependent data by suing single frame animation techniques. This system consists of a PC microcomputer based animation controller, a video frame buffer, and a 1/2" editing video tape recorder and is designed to function as a remote device from where the numerical simulation is being run. The remote application can access the display system directly by using remote procedure calls or by sending data files containing representations of graphics to the device for later processing on to video tape. This system has been used by a number of LBL scientists for displaying the results of time dependent numerical simulations.

Over fifteen requests for detailed plans for building this device have been made. These requests came from a number of universities, research laboratories, and industry. Several of these organizations have replicated the system and one commercial organization is designing a product based on this technology.

DOE - Lawrence Berkeley Laboratory

HUMAN MAMMARY EPITHELIAL CELLS

Human mammary epithelial cell strains derived from normal and malignant tissues, and cell lines derived from normal cells transformed to immortality after exposure in vitro to benzo(a)pyrene, have been provided to numerous investigators and biotechnology companies. These cells are being used to study normal and abnormal human cell physiology and biochemistry, immunology, growth factor and oncogene action, genetics, and mechanisms of carcinogenesis. Companies currently using these cells include: Cetus Corporation, Eli Lilly, Hybridtech Inc., and Syntex Research. Academic and research organizations using these cells include: Academy of Science (DDR), Baylor College of Medicine, Children's Hospital-Oakland, Dana-Farber Cancer Institute, Dutch Cancer Institute, Imperial Cancer Research Fund, INSERSM, National Cancer Institute, Peralta Cancer Research Institute, U. Arkansas, U. California, U. Colorado, U. Southern California, U. Wisconsin, and Veterans Hospital in New York.

DOE - Lawrence Berkeley Laboratory

BIOGLASS APPLICATION FOR HELPING DIABETICS

In the first meeting of the SDIO Bio-Medical Applications panel, it was determined that new Bioglass material promises a dramatic improvement with another new bio-medical innovation - the Programmable Implantable Medication System(PIMS) which itself uses satellite telemetry technology and NASA Mars Viking Lander technology to automatically dispense insulin for diabetics. The inventor of the PIMS, Mr. Fischell of Johns Hopkins University Applied Physics Laboratory is a member of the SDIO Bio-Medical Technology Applications Panel.

DOD - Strategic Defense Initiatives Organization

SAFER METHODS FOR FOOD PRESERVATION

The Department of Energy is currently negotiation an agreement with the Lawrence Livermore National Laboratory to use the Linear Accelerator technology developed under the SDI Program as the principal source for implementing a large scale food irradiation program. The program will be initially implemented in six states (Hawaii, Alaska, Oklahoma, Florida, Washington, and New Jersey). This technology provides a much safer (non-nuclear) source to irradiate food so that meats, fruits, and vegetables can be stored for prolonged periods without spoilage.

DOD - Strategic Defense Initiatives Organization

NEUTRAL PARTICLE BEAM (NPB) MEDICAL AND INDUSTRIAL SPINOFFS

Linear Accelerator technology developed in response to SDI requirements for a source for neutral particle beam technology at Los Alamos National Laboratory has lent itself to spinoff applications for both Medical and industrial applications. The key element of the technology is a Radio Frequency Quadripole linear accelerator, known as an "RFQ" Linac. Originally a Russian concept proposed in 1970, the first RFQ was tested at Los Alamos in 1980. Competition efforts on Neutral Particle Beam requirements led to the invention of the "precision segment" RFQ Linac by Boeing and AccSys Technology Incorporated which produced the base line design for the initial stage of the accelerator in the SDI Neutral Particle Beam Integrated Space Experiment. Related supporting technologies (ion injector, rf power source, vacuum pumping system, water cooling system, mechanical structures, instrumentation and controls) have also been pushed by NPB requirements resulting in smaller, lighter, rugged, more efficient and reliable and reliable systems. Actual and projected applications of this technology follow:

PRODUCTION OF RADIOISOTOPES FOR MEDICAL DIAGNOSIS

The RFQ design has now been incorporated into a compact proton linac to produce medical radioisotopes for Positron Emission Tomagraphy via a SBIR frant from the National Cancer Institute. These isotopes are principally used in study and diagnosis of brain and heart disease. The new technology has produced a smaller, lighter (easier to shield), less complex, more energy efficient and safer source than other methods. Commercial production is expected by 1989. Additional medical needs are being assessed for other radionscopes created by this new technology.

CANCER THERAPY APPLICATIONS

Loma Linda University hospital in southern California has selected the SDI derived RFQ Linac device for use in their ion therapy cancer treatment facility now under construction. It is anticipated that three to five more facilities will be built using this technology over the next five to ten years.

SEMICONDUCTOR MANUFACTURE ENHANCEMENTS

Applications of the NPB RFQ Linac technology into an ion implantation device which will be used for doping semiconductor materials with high energy ions of boron, phosphorus and arsenic is being designed. Manufacturing devices will be built at users facilities under license agreements.

OIL WELL LOGGING AND MINERAL SURVEYS

The RFQ Linac's compact size lends itself to applications in the fabrication of survey tools for Oil well logging operations where it can be used in a well shaft without the danger of contaminating an oil field with a dropped radioisotope inherent with the current procedure. The instrumentation could also be used to assay mineral content in mining operations.

DOD - Strategic Defense Initiatives Organization

NEW INSTRUMENTATION FOR ENTOMOLOGISTS

The Laser Doppler Radar technology developed under SDI contract at Oak Ridge National Laboratory has been packaged into a small prototype device which can be used to detect and discriminate the presence of various species of insects. This new device could provide an entirely new and more effective analysis tool for entomologists. This device is useful in detecting the presence of a queen bee in hives, the presence of various species of harmful insects, and particularly valuable in identifying the African "Killer Bee". The U.S. and Mexican Departments of Agriculture are currently working with the inventor regarding applications of this technology.

DOD - Strategic Defense Initiatives Organization

HIGHWAY BRIDGE SAFETY ANALYSIS

A potential application for both the Neutral Particle Beam associated RFQ linac work at LANL and Laser Doppler Radar Technology at Oak Ridge National Lab is the inspection and analysis of potentially dangerous bridge structures in the national highway system. The SDIO Office of Technology Applications is working with the Department of Transportation on these potential applications.

DOD - Strategic Defense Initiatives Organization

SECTION F

EMPLOYEE EXCHANGE

LLNL AND PHILIPS RESEARCH LABORATORIES EXCHANGE RESEARCHERS

THE TECHNOLOGY

LLNL and Philips Research Laboratories of Eindoven, Holland have signed an agreement to exchange two research engineers for one year. The industrial exchange is funded by the U.S. Strategic Defense Initiative Office through the U.S. Air Force Weapons Lab. One of the world's largest corporations, Philips is a leader in many electronics fields. It has nine research labs, including three in the U.S. Both Philips and Livermore are two of the world's recognized centers for precision machining.

TECHNOLOGY RECIPIENTS

Under the exchange, Jeff Roblee of LLNL's Materials Fabrication Division, began working at Philips' Eindhoven facility in September, 1986. At Philips, Roblee is studying the firm's ultra-precision grinding machines. He is also studying grinding work performed at leading companies and universities in West Germany.

Roblee's counterpart at Philips, mechanical engineer Jelm Franse, starts a one year stint at LLNL in summer, 1987. Franse is disseminating Philips' expertise in ultra-precision grinding. He is also studying Livermore's capabilities in precision machining, with emphasis on facilities such as the large Optics Diamond Turning Machine and the Precision Engineering Research Lathe.

COMMERCIAL USES AND BENEFITS

One of the goals of the exchange is to upgrade the technology held by LLNL (and U.S. industry) for the ultra-precision grinding of brittle materials, such as glass and ceramics. This should aid in the development of Strategic Defense Initiative concepts. Many NASA space science and civilian programs would also benefit from improved optical fabrication techniques. In particular, these would lower the cost and improve the feasibility of large astronomical telescopes operating at visible and x-ray wavelengths.

DOE - Lawrence Livermore National Laboratory

EXCHANGE AGREEMENTS PLACE INDUSTRY SCIENTISTS IN RESIDENCE AT ARGONNE

THE TECHNOLOGY

Dow Chemical U.S.A. and Argonne National Laboratory have signed an agreement that will place a series of Dow scientists in various research programs at Argonne. The first Dow scientists arrived at Argonne in mid-February 1988.

Under the Dow-Argonne industrial residencies agreement, each Dow researcher will be at Argonne for periods of a few weeks to several months. The first "resident", from Dow's Analytical Laboratory in Midland, Michigan, will work with Argonne's Chemistry Division on novel methods for the analysis of polymeric materials. During his stay at ANL, the Dow researcher will identify suitable topics for later residents.

Dow is one of several companies that Argonne hopes to have working onsite over the next couple of years, and the first to sign a long-term agreement. Scientists from Borg-Warner, Exxon, and Allied-Signal have been in residence for short, limited periods over the past 18 months under a DOE-sponsored residencies program that assists scientists from a broad spectrum of industry to work at DOE laboratories for periods of up to 12 months each.

TECHNOLOGY RECIPIENTS

Both Argonne and industry will benefit from this program.

USES AND BENEFITS

Having an agreement, rather than exchanging staff on an ad hoc basis, provides technical continuity and fosters a strong relationship between the industrial firm and Argonne. The focus on identifying research topics for subsequent researchers orients research toward solving pertinent problems for industry, and helps provide Argonne with a realistic picture of industry's resarch needs.

DOE - Argonne National Laboratory

SECTION G

USE OF LABORATORY FACILITIES

TEST BED FOR A FUTURE FUSION REACTOR

THE TECHNOLOGY

The Rotating Target Neutron Source (RTNS-II) is unique for two reasons. First, it is one of the few facilities in the world designed to provide high-energy neutrons to study the way materials will behave inside future fusion reactors. It is the world's most intense controlled source of fusion-energy neutrons. Second, it is an international center for fusion materials research: Experimenters from around the U.S., Japan and other countries use the facilities. Since 1982, the Japanese government has provided matching funds for the facility, doubling its total operating budget.

TECHNOLOGY RECIPIENTS

The blueprints and specifications for RTNS-II have been transferred to the National Technical Information Service. The table below shows user participation in RTNS-II since 1979, when the facility opened. The data are tabulated by number of major experiments.

USES AND BENEFITS

Hundreds of scientists have used this facility for research they would be able to do in few other laboratories. Since 1979 more than 2,000 samples have been tested. These experiments were done by investigators from 16 national laboratories throughout the U.S., as well as from universities and industry. Researchers have used the facility to study: the mechanical and physical properties of metals; the optical properties of laser glass; the properties of superconductors needed to contain the fuel in the Laboratory's Magnetic Mirror device; the properties of insulators; and the effects of radiation on organic samples, such as human liver enzymes.

Many experiments, although identified as being conducted by a single country, were actually planned and conducted to meet joint research objectives. All results from this cooperative activity are published in English in literature available to the public.

User Participation in the RTNS-II

	FY80	FY81	FY82	FY83	FY84	FY85	FY86
Estimated use ratio			(Percent of capacity)				
University	10	10	35	35	35	35	60
Industrial	60	60	40	40	40	40	20
Others	--	--	--	--	--	--	--
Laboratory	30	30	25	25	25	25	20
Total operating cost ($ in millions)	1.7	1.9	2.8	3.7	3.9	3.6	3.2

DOE - Lawrence Livermore National Laboratory

COMPUTER CENTER LINKS FUSION COMMUNITY

THE TECHNOLOGY

Another unique Laboratory facility that involves extensive technology transfer is a computer center that links fusion energy researchers across the nation. Established in 1974, the National Magnetic Fusion Energy Computer Center (NMFECC) boasts four Cray supercomputers plus a number of smaller machines. Users nationwide can access the computers to share information, codes, and data 24 hours a day, 365 days a year. Most of the remote users rely on telephone lines for data transmissions, but several major locations communicate with the center by satellite.

TECHNOLOGY RECIPIENTS

NMFECC is used by some 4,000 scientists at over 100 research sites in universities, national laboratories, and private industries. Examples include the Princeton Plasma Physics Laboratory, Oak Ridge National Laboratory, Los Alamos National Laboratory, and General Atomic Technologies - all of which have "earth stations" for satellite communication. Below is a table of users for the past seven years. As the table indicates, the number of users doubled from 1984 to 1986.

USES AND BENEFITS

Theoretical physicists, design engineers, and planners use the facility for every phase of their work, from concept-testing through building experiments to collection and analysis of experimental data. The center offers several outstanding benefits to participants. One is cost savings: The center's extensive computing resources guarantee researchers the best in computational power and speed, while relieving them of the burden of costly equipment purchases. Supercomputers like the Cray cost upwards of $13 million each.

User of NMFECC

	FY80	FY81	FY82	FY83	FY84	FY85	FY86
Computer users			(Number)				
University	394	468	571	582	742	937	1229
Laboratory	696	806	959	1047	1249	2526	2778
Industrial	85	93	91	90	120	337	296
Others	62	67	58	58	--	--	--
Estimated use ratio		(Percent of Capacity)					
University	26	23	28	29	26	31	27
Laboratory	68	70	63	61	72	61	65
Industrial	2	2	2	4	2	8	8
Others		3	6	6	--	0	--
Total Operating cost ($ in millions)	9.0	9.9	11.3	12.8	15.3	19.7	23.6

BEVALAC PHYSICS RESEARCH

In addition to basic physics studies by academic and national laboratory researchers, studies are occasionally conducted at the Bevalac by private firms. During the past year, Boeing Aerospace Company used the Bevalac beam to investigate the effects of cosmic rays on space vehicle computer chips. For their purposes, the Bevalac is an effective simulator of cosmic radiation. Also, Science Applications International Corporation used deuteron beams at the Bevalac to confirm the accuracy of a computer code designed to predict neutron-production cross sections at low energies.

DOE - Lawrence Berkeley Laboratory

ETHERNET COMMUNICATIONS INTERFACE

The Bevalac Software Support Group of the LBL Nuclear Science Division provides data acquisition facilities for Bevalac experimental groups. Development of a new, VME-based data acquisition system over the past two years required a fast and flexible Ethernet communications interface for data transfer and recording. A leading communications manufacturer, Communications Machinery Corporation (Santa Barbara, CA.), provided an interface that came closest to meeting LBL's requirements. However, detailed tests showed serious performance problems. At LBL's request, a series of specific product changes were made by the manufacturer. From timing tests performed at LBL, several of these changes were shown to increase communications throughput by up to 60%. These enhancements have been incorporated into the released product and are being used in several commercial distributed control and data acquisition applications.

DOE - Lawrence Berkeley Laboratory

ION IMPLANTATION STUDIES AT THE SUPERHILAC

The production of new semiconductors by deep implementation of heavy ions in substrates was studied during 1987 by several students of Professor Nathan Cheung of the University of California at Berkeley. As part of a collaborative program, the implanted material was then shared with the research departments of several semiconductor manufacturers. In addition, surface modification implantation experiments were carried out using heavy-ion beams from both the Abel and the Adam injectors at the SuperHILAC, LBL's 8McV heavy ion linear accelerator. This work, conducted by Peggy Hou of the Materials and Chemical Sciences Division, was funded by a grant from the Electric Power Research Institute.

DOE - Lawrence Berkeley Laboratory

RCA RADIOFREQUENCY POWER AMPLIFIER

During 1986 and 1987, Accelerator & Fusion Research Division physicists at the SuperHILAC collaborated with RCA in the testing of an RCA vacuum tube for use as an rf amplifier. The SuperHILAC accelerator power supply system served as a unique testbed for a tube intended for wide industrial application. Installation, conditioning and operational data were shared.

DOE - Lawrence Berkeley Laboratory

SECTION H

INDIVIDUAL LABORATORY VISITS

TRANSURANIC AEROSOL MEASUREMENT SYSTEM OFFERS CLEARCUT ADVANTAGES

THE TECHNOLOGY

LLNL researchers have developed a computer-controlled system for measuring airborne transuranic elements. The system offers more features than anything now on the market. It is very efficient for measuring particles as large as 10 micrometers in diameter and can handle a wide range of flow rates. A detector mounted in the instrument's air sampling pipe sounds an alarm immediately if there is a release of radioactivity. After the sampling time, the filter is moved to a vacuum chamber for more sensitive off-line analysis.

A microcomputer drives the filter transport mechanism, operates a 256-channel pulse height analyzer, performs calculations, checks calibration and drives a matrix display. Its operation can be changed or enhanced by simply changing software, written in modular fashion. It can also communicate trend, alarm and other data to a central computer.

TECHNOLOGY RECIPIENTS

About 60 units are planned for production at DOE's Rocky Flats, CO plant for use there. At least four companies have already expressed interest in the machine, and have examined LLNL's prototypes. It is expected that the device, called WOTAMS (Workplace Transuranic Aerosol Measurement System) will evolve into a commercial product to replace those less sensitive instruments now widely used in both research and production environments. WOTAMS is the public domain.

USES AND BENEFITS

Compact, extremely sensitive detectors are an absolute requirement in facilities processing elements like uranium, plutonium and americium. WOTAMS is much more sensitive than current units in detecting and measuring alpha particles. It is a high reliability system with operational self-checking and periodic source-calibration checks. Since WOTAMS produces very accurate data, it minimizes the need and additional expense for a counting laboratory to analyze air samples.

DOE - Lawrence Livermore National Laboratory

SECTION I

INFORMATION DISSEMINATION

DOES YOUR BUILDING MEASURE UP?

THE TECHNOLOGY

Scientists at the Solar Energy Research Institute (SERI) have developed a computerized method to determine a building's energy performance and peak loads. The new method has a range of applications that include energy ratings and predictive load control.

Information for each performance determination is gathered by commercially available sensors linked to a microcomputer. The computer is placed inside the test building where a technician enters preliminary information such as wall materials, window area and location, and shading mechanisms. The technician also attaches electric heaters to the computer so that heating patterns can be carefully controlled during the two- or three-day test period.

Measurements are taken automatically while the SERI-developed software, called BEVA (an acronym for Building Element Vector Analysis), calculates performance parameters related to heat loss, heat storage, and solar gains. Such parameters are used in an hour-by-hour simulation to predict the building's long-term energy use and peak loads.

TECHNOLOGY RECIPIENTS

SERI's method has been used to analyze the energy performance of several Colorado and Wisconsin homes. Researchers are now enhancing the software and refining test methods for different applications, a task that is being accomplished through cooperation with businesses and universities. For example, SERI has joined with the International Energy Agency and local building firms to assess the performance of a design home in Boulder, Colo. Other projects now under way involve studying the performance of nonresidential buildings and interactions with heating, air conditioning, and ventilation equipment.

USES AND BENEFITS

SERI's method has proven its ability to rapidly assess energy performance claims. This type of information also is useful to builders and buyers who want the most reliable predictions of energy use. And for architects who wish to improve the efficiency of future buildings, SERI's method offers an opportunity to resolve discrepancies between predicted and actual performance.

DOE - Solar Energy Research Institute

PREDICTING WIND TURBINE PERFORMANCE

THE TECHNOLOGY

Energy extracted from the wind flowing over the continental United States could supply about twice our annual consumption of electricity. The value of this clean, renewable energy source is already recognized by the private sector--especially in California, where more than 14,600 privately operated wind turbines now constitute about 3 percent of the state's total installed electric capacity.

Scientists at the Solar Energy Research Institute (SERI) are supporting America's growing wind industry with the development of a computer code to predict wind turbine performance. The versatile code, called PROPPC, is available in Fortran-77 for use on personal computers.

SERI's new design tool is based on AeroVironment's PROP, a code that calculates performance based on blade geometry and two-dimensional airfoil characteristics along the blade. PROPPC improves the usefulness of PROP in several ways: it can analyze up to 20 spanwise blade segments; it predicts machine performance even when the rotor shaft is tilted or the rotor does not directly face into the wind; and its output can be expressed in dimensional engineering units as well as nondimensional ratios.

PROPPC also features two special subroutines that enhance its accuracy, producing a realistic performance curve from low to high wind speeds even after stall has been reached.

TECHNOLOGY RECIPIENTS

SERI scientist routinely use PROPPC to predict the power output of experimental wind machines. The code is also widely used by companies such as Fayette Manufacturing and U.S. Windpower, two of the top producers of wind-generated electricity in the country.

The tabulated output of this computer code allows researchers to make realistic comparisons between differing wind turbine designs. Practical results of such design studies include improved, second-generation rotor blades for the retrofit market. These blades will first be used on the Westwind Phoenix.

USES AND BENEFITS

SERI's easy-to-use computer code allows researchers and engineers to better predict wind turbine performance and peak loads. This knowledge is important in designing blades that are more resistant to structural fatigue, a problem that increases maintenance costs on commercial wind turbines.

DOE - Solar Energy Research Institute

PRECAST ELEMENTS FOR REHABILITATION OF EXISTING STRUCTURES

THE TECHNOLOGY

The conventional method for rehabilitation of a navigation lock is: to close the lock to navigation, dewater the lock, and remove all the old deteriorated concrete. Formwork is then used to place new air-entrained concrete to bring the lock back to its original dimensions.

One of the problems faced when using this method is the cracks that develop in the new concrete shortly after removal of the formwork. A numerical model study was used to determine the cause of the cracking and it was found to be due to the tremendous restraint provided by the large mass of original concrete which remains in the lock walls. The new concrete wants to shrink upon cooling and drying, but the existing concrete resists this movement and the cracks develop.

One solution to the cracking problem is the use of a precast stay-in-place forming system. A system was designed and demonstrated under a contract with ABAM Engineers, Inc. The concept is that a high-quality precast panel is fastened to the existing concrete to bring the lock back to its original dimensions. The area between the panel and the existing concrete is filled with air-entrained concrete.

TECHNOLOGY RECIPIENTS

Several techniques have been and are being used to transfer this technology to the private sector. These include: (1) contracting to private industry for the design and demonstration of the system, (2) demonstrating the constructability of the system by the use of a field test, (3) publishing an article in The REMR Bulletin which is widely distributed outside the government, (4) incorporating the technology into the Concrete Maintenance and Repair course which is presented by the Corps of Engineers four times each year, (5) preparing a video report describing the system, (6) preparing articles for technical journals, and (7) presenting the technology at several technical meetings.

A few of the recipients of this technology are: (1) ABAM Engineers, Inc., Federal Way, WA; (2) Stresscon Corporation, Colorado Springs, CO; (3) Premier Waterproofing, Denver, CO; (4) Harza Engineering Company, Chicago, IL; (5) JAYCOR, Vicksburg, MS; and (6) Brown & Root Development, Inc., Houston, TX.

USES AND BENEFITS

This system is a viable method for lock wall rehabilitation and provides a concrete surface of superior durability with minimum cracking. Cost is very competitive with conventional forming and concrete placement. The system has the potential for significant reductions in the length of time a lock must be closed to traffic for rehabilitation and could eliminate the need for dewatering the lock chamber. A contract was recently awarded for the rehabilitation of Lock No. 22 on the Mississippi River using this system.

DOD - Army Engineer Waterways Experiment Station

HUMAN-FACTORS DESIGN GUIDELINES DEVELOPED FOR U.S. NUCLEAR FACILITIES

THE TECHNOLOGY

Much recent publicity has focused on the need for stronger man-machine links in proper operation of nuclear power plants. A new report by LLNL specialists is based on the premise that planning, designing and scheduling operations with an eye to the human factor is critical to the success of nuclear power plant operations. The report was prepared for DOE's Office of Nuclear Safety by LLNL's Nuclear Systems Safety Program.

TECHNOLOGY RECIPIENTS

First issued in July 1985, the manual was received well by DOE national laboratories. It currently is being disseminated throughout the nation's private nuclear power industry. To date some 400 requests have been received for copies of the report.

USES AND BENEFITS

The guidelines emphasize the human element in the design of nuclear facilities, particularly with regard to maintainability. They apply a set of principles to a system, subsystem, equipment or component to ensure conformance to human factors practices. The guidelines may be used for designing new facilities and for evaluating and modifying existing ones. They also should prove useful in determining proper training and organization of personnel as well as in allocating functions to humans or machine, or to some combination of the two.

The material is written in easy-to-understand language and is complemented by numerous charts, diagrams and tables. Text is organized into three section: engineered hardware, facility support, and personnel. Each section is tabbed for convenience and further divided into guidelines containing definitions and general and specific human factors design principles.

DOE - Lawrence Livermore National Laboratory

CHECKLIST HELPS MANAGERS KEEP COMPUTERS SECURE

THE TECHNOLOGY

LLNL's Technology Information Systems, together with Control Data Corp., has assembled a comprehensive checklist for assessing the security of computer-based information system. The material covers more than 800 security and survivability related issues in 13 categories, ranging from personnel policies and training to accessing data. The checklist is the first comprehensive means of determining the vulnerability of a computer system, be it one PC or a large network. The information was derived from Livermore's active involvement with sensitive resources at national laboratories and from guidelines used by banking institutions in their maintenance of accounts and fund transfers.

TECHNOLOGY RECIPIENTS

The checklist was originally prepared for the U.S. Air Force Logistics Command and has been widely disseminated throughout that branch of the armed services. It also is being published in book form as an important tool for the business manager concerned about the integrity of computer information.

USES AND BENEFITS

Assuring the security of information held in computer system has become a major concern to federal agencies and private industry. The responsibility for protecting this information ultimately rests with administrators and managers of computer facilities. Often, however, these people do not have an extensive command of highly technical computer terms and concepts. LLNL's computer security checklist does not require an expert knowledge of either computer software or hardware and should prove extremely helpful to these people, as well as to computer security officers, consultants, risk managers, quality assurance staff, project managers, and educators. Data processing and systems security experts should also find it of great value. The checklist may also be used in a limited fashion such as reviewing specifications of future systems or establishing security standards.

The checklist is written in question form and is divided into two general sections - security and survivability. It also features a thorough bibliography on computer security and a comprehensive glossary of technical terms.

DOE - Lawrence Livermore National Laboratory

MICROCOMPUTER APPLICATIONS FOR COASTAL ENGINEERING (MACE)

THE TECHNOLOGY

Coastal Engineering Research Center (CERC) scientists and engineers at the Waterways Experiment Station (WES) have initiated a series of microcomputer programs (MACE) to assist coastal engineers. MACE software is designed for easy use by coastal engineers, regardless of any prior microcomputer experience.

MACE applications fit one of two functional types:

> Coastal engineering utility applications which perform computations that are commonly repeated many times in the course of coastal engineering planning and design projects.
>
> Specialized applications resulting from recent research or field experience.

MACE programs are original software which readily executes on a microcomputer with moderate capabilities. CERC is currently directing its effort toward design guidance as presented in the Shore Protection Manual.

TECHNOLOGY RECIPIENTS

More than 200 individuals, engineering firms, universities, federal, state and local government agencies are using MACE. Because all MACE programs are in the public domain, the exact number of users cannot be determined and the total number of users probably far exceeds the number given above.

USERS AND BENEFITS

MACE programs are used by coastal engineers and planners to significantly reduce the amount of time spent in performing computations that are repeated many times in the course of coastal engineering planning and design projects. CERC is working to increase the capability and speed of microcomputer software through MACE to make the work of a coastal engineer easier.

DOD - Army Engineer Waterways Experiment Station

ALTERNATIVES TO ANIMAL TESTING IN TOXICOLOGY

THE TECHNOLOGY

Use of laboratory animals in toxicology testing is an explosive national issue. The cosmetics industry, for example, is under fire from animal rights groups for relying heavily on the standard Draize test (instilling cosmetic compounds into rabbits' eyes to test for irritancy). Other nations, notably Great Britain, have taken aggressive legislative steps to find alternatives to the use of experimental animals. The U.S. has not been as progressive, and controversy is growing rapidly.

A research team at the U.S. Army Chemical Research, Development and Engineering Center (CRDEC), led by Dr. Harry Salem, is investigating several alternatives to whole animal testing. These alternative approaches include both in vitro (cellular) and computer models.

TECHNOLOGY RECIPIENTS

Presentations on CRDEC's alternative program were made to scientists at the Department of Agriculture, Food and Drug Administration, Environmental Protection Agency, National Cancer Institute, Medical College of Virginia, university of Pennsylvania, Dupont's Haskell Laboratory, Hercules Incorporated, Clorox Company, Pennwalt Corporation and Rutgers University.

Specifically, CRDEC is collaborating with Rockefeller University to correlate in vitro methods with standard in vivo Draize test results. Likewise, CRDEC is working with Health Designs, Incorporated to develop computer models based on structure-activity relationships to estimate Draize test results.

Dr. Salem has recently edited and contributed four chapters in a textbook entitled Inhalation Toxicology: Research Methods, Applications, and Evaluation. This book is rapidly becoming a standard reference text used worldwide by toxicologists. He has also produced an excellent videotape on the alternative to animals program which has been shown frequently to members of scientific symposia and to prominent national and international visitors to the Center. The capstone in Dr. Salem's efforts, though, has been the publishing of new proposed federal guidelines for the Environmental Protection Agency's Toxic Substances Control Act which include, among others, mandatory environmental testing of new chemicals using microcosm systems, a technique validated and modified in one of Dr. Salem's laboratories at CRDEC.

USES AND BENEFITS

Alternative systems, whether in vitro or computer models, cannot be expected to replace all whole animal testing. however, promising alternative screening methodologies should reduce the number of animals required for testing and at the same time find acceptance in the scientific and regulatory communities and allay public concern.

DOD - Army Chemical Research, Development & Engineering Center

MICROWAVE ENERGY FOR RAPID SAMPLE PREPARATION

THE TECHNOLOGY

Microwave energy for sample digestion with mineral acid in closed Teflon vessels affords a means of rapid heating to temperatures substantially above the normal boiling points. At these elevated temperatures many materials decompose rapidly. The National Bureau of Standards has played a leading role in placing this emerging technology on a scientific footing and CEM Corporation, a maker of microwave equipment for laboratory and research purposes, worked with NBS in systematic studies of this new technology. A book on sample preparation using microwave techniques is being edited for the American Chemical Society. This compendium will allow industrial chemists to predict temperature and pressure conditions and use this new technology safely. Publications, special symposia and meeting reports on the topic led to one-on-one consultations with hundreds of companies.

TECHNOLOGY RECIPIENTS

In addition to the collaborating company, CEM, over 450 researchers from other companies, universities, and research laboratories have requested information or come to NBS to learn of this new technology.

USES AND BENEFITS

The development of closed vessel microwave acid decomposition has increased the productivity of many industries doing elemental analysis. Depending on the sample type, preparation times have been cut from 8 hours to 20 minutes. As a result many industries are using microwave assisted decompositions as the predominant method of sample preparation. Some of America's largest companies have applied this new technique to sample types such as: oils, nuclear fuels, plastics, foods, medicines, ores, and environmental samples. Volatile elements such as selenium, phosphorus, tellurium, and vanadium can be quantitatively retained in these sealed vessels using microwave decomposition prior to instrumental analysis.

Because microwave digestions occur in a well-defined, precisely controlled system, they are suitable for integration into automated applications. Acid digestion conditions have previously been too arbitrary for automation.

Research has been conducted to identify fundamental relationships and to develop methods that allow the analyst to predict the conditions that will be generated during microwave digestion before programming and running the equipment. As a result, many new applications as well as historically difficult problems can be dealt with using this new technique. The technique has been tested on all the major sample types including biological, botanical, geological, alloy, and glassy samples and has demonstrated advantages for each of these sample groups.

DOC - National Bureau of Standards

LINEWIDTH STANDARDS FOR INTEGRATED CIRCUITS

THE TECHNOLOGY

The technology of making very small structures for integrated circuits has evolved faster than the technology for making measurements of their very small dimensions. This gave rise to serious problems in the manufacture of integrated circuits. Study by NBS in collaboration with the industry revealed that the problems were very fundamental and, in 1975, NBS launched a new program aimed both at developing the necessary knowledge to solve these problems and at developing the appropriate standards for the desired measurements.

The theoretical aspects of this project produced information so fundamental and radically different from commonly accepted theory and practice that portions of the textbooks on high resolution optical microscopy were rewritten. The experimental aspects centered on the design and construction of a new optical system that could be described theoretically and used, not only as a research tool to compare experimental and theoretical results, but also as a practical instrument to calibrate future dimensional standards.

The first dimensional standard specifically designed for the integrated circuit industry, the most expensive standard ever produced by NBS, ($5,016), appeared in 1978 and NBS could not calibrate these standards fast enough to meet the demand. NBS continued to work with the industry to implement the new metrological techniques and to teach the proper use of the new standard through a series of technical publications coupled with seminars and workshops. The large demand for this standard has continued to the present and NBS is currently automating the calibration in hopes of finally being in a position to supply enough of these photomask standards.

As even smaller microcircuits are under development, work with industry continues on standards for even smaller linewidths.

TECHNOLOGY RECIPIENTS

Although the present program was motivated by the particular needs of the semiconductor industry, the work has impacted other industries where the measurement of small dimensions are critical (e.g., the tape head industry).

USES AND BENEFITS

The techniques developed at NBS as part of this program are currently used throughout the world and there is a constant demand for additional standards: for smaller dimensions, for different kinds of measuring instruments, and for specific applications. The benefits to the country resulting from the past NBS work are hard to estimate but run into tens of millions of dollars per year and are still growing as additional results and future standards make their appearance.

DOC - National Bureau of Standards

NEW INSTRUMENTS MEASURES SOIL SALINITY

An Agricultural Research Services (ARS) scientist recently developed new instrumental methods and devices for measuring soil salinity directly without the need for soil sampling and laboratory analysis. The scientist contacted several companies that make and market instruments, as a result, the equipment is now manufactured in the U.S. by two firms and is marketed here and in overseas markets. The ARS scientist has also been active in assisting users and potential users to learn the procedures and benefits of this new instrument. He prepared a bulletin for the Food and Agricultural Organization of the United Nations and trained users from the Soil Conservation Service (SCS) in five states. As a result of the latter effort, commercial versions of the equipment were purchased by SCS and are being used in eleven western states. Many commercial sales have also been made overseas.

DOA - Agricultural Research Services

A LABORATORY STUDY OF ASPHALT CONCRETE MIX DESIGNS FOR HIGH-CONTACT PRESSURE AIRCRAFT TRAFFIC

Users have indicated a growing concern with the abilities of conventional aircraft runways to support the increased use of aircraft with high-contact tire pressures. Asphalt concrete mix designed using the conventional Marshall method has proven satisfactory; it was uncertain whether this could be expected to sustain tire pressure exceeding 35 psi. This laboratory undertook to: (1) Study the effects of high-contact pressure (300-400) psi aircraft tires on properties of conventionally designed asphalt concrete surface mixes and (2) Propose a mix design procedure for optimized performance of the mix. The study focused on asphalt concrete mixes compacted at laboratory pressures several times greater than those traditionally used. Mixes were compacted at pressures of 100, 200, 300, and 400 psi in a gyratory compaction machine and 75 blows per side, using a hand or mechanical impact hammer. Traditional weight volume, Marshall stability, and flow properties were determined for the prepared mixes. Optimum mix designs were selected, using current criteria for "heavy-duty" mixes from AFM 88-6. Additional samples were prepared for mixes at, and bracketing, this optimum design and additional tests were conducted. These non-traditional tests included indirect tensile, direct shear, accelerated aging, and unconfined creep. Finally, limited testing was conducted using an asphalt modified with Chemkrete. Results suggest that the current design method of "heavy-duty" criteria can be used; however higher compactive efforts will be required during construction to achieve the higher densities required for high-tire pressures. This may be difficult with current compaction equipment. Additionally, the "best" mixes contain 1/2 percent less asphalt cement which may lead to premature environmental deterioration. This study was a part of the effort examining the impact of the F-15C/D on the USAF's flexible pavements. The technology investigated in this effort will, primarily, be of value to the US Air Force. However, with the introduction of newer heavy fighter aircraft to the Air National Guard and Air Force Reserve units, where these aircraft will jointly use civilian airfields, the technology is important to the civilian sector.

DOD - Air Force Engineering & Services Center

ASPHALT-AGGREGATE INTERACTIONS IN HOT-RECYCLING

Because of the need to conserve airfield pavement materials, this laboratory attempted to improve the design technology of hot asphalt concrete recycling operations. This was done by studying the compatibility of asphalt aggregate interactions to develop correlations which could lead to improved design technology. Since the savings realized by recycling can be as high as 40 percent in the rehabilitation of aging Air Force pavements system, an improved technology for recycling would be cost-effective. This effort attempted to characterize the asphalt-aggregate interaction, where premature failures of asphalt concrete pavements begin. Despite extensive research on the physical characterization of the asphalt=aggregate bond, little has been known about the interaction phenomenon. The results of our study indicated that the strength of recycled mixtures equals or exceeds the strength of comparable virgin mixes. Hot recycling is viable and can be applied to selection of asphalt-aggregate combinations for recycled or virgin mixes. The selection guidelines developed will help the engineer to avoid selecting asphalt-aggregate combinations subject to premature failures, and thus, eliminate one of the primary objections to recycling.

DOD - Air Force Engineering & Services Center

SOIL STABILIZATION FOR ROADWAYS AND AIRFIELDS

Stabilized soil pavement construction can provide obvious advantages in mobility operations or provide an economic alternative to conventional pavement construction. Air Force Manual 88-7 (AFM 88-7) Chapter 4, published several years ago, needed to be updated to reflect chemical soil stabilization. Soil stabilization is achieved by adding lime, cement, fly-ash, asphalt, and combinations of these to soils to produce desired bearing capabilities for pavements. The knowledge gained from research performed in developing the Soil Stabilization Index System (SSIS) was implemented in this effort, which produced comprehensive procedures for chemical soil stabilization, to include methodologies for selection, design, construction, specification preparation, inspection, and life-cycle costing of stabilized pavements for roadways and airfields. The research provided a complete, state-of-the=art reference for construction of chemically stabilized soils for use in pavements. This reference can be used by HQ AFESC/DEMP in creating a new Air Force soil stabilization manual, and by Major Air Commands as an interim, guideline for stabilization of roadways and airfields for base pavements engineers worldwide.

DOD - Air Force Engineering & Services Center

CATALYTIC IGNITION TECHNOLOGY

Sandia National Laboratories personnel developed a platinum catalytic igniter for lean hydrogen air mixtures. This igniter could have an important impact in nuclear reactor safety, and Sandia has been active in transferring this technology to the nuclear power industry. In addition, during the last 18 months, researchers from the Electric Power Research Institute, Atomic Power of Canada Limited (AECL) and Kraftwerk Union (West Germany) have traveled to Livermore to learn more about the igniter. As a result of these discussions and transfer of the technology, igniters based on the Sandia design have been successfully tested in Canada and West Germany.

Currently, electrically heated glowplug igniters are used in the containment structures of several types of power generating nuclear reactors to reduce the problems associated with the build up of hydrogen which may occur during a loss of coolant accident (LOCA). There are significant fire and explosion hazards associated with the large volume of hydrogen that could be produced in a LOCA, and the purpose of intentional ignition is to burn the hydrogen at sufficiently low concentrations that little damage is done to the containment or its contents. One of the most unlikely events in a LOCA is station blackout, however, if this occurs, electrical power to heat the glowplug igniters might not be available. This is the situation in which the catalytic igniter could help, since it does not require an external source of power to cause ignition. Rather, the catalytic igniter uses the latent chemical energy in the hydrogen-air mixture itself to heat the igniter to ignition temperatures (~585 degrees C). This is accomplished by suing platinum to catalyze the heat-generating reaction between hydrogen and the oxygen in air.

Benefits: The benefits of the technology have not been fully realized. However, in the U.S. the catalytic igniters could provide a safety backup for electrically heated igniters and in Germany and other countries, installing catalytic igniters could save the cost of high reliability power supplies, containment penetrations, cabling and control systems otherwise required in retrofitting their reactors with hydrogen ignition safety systems. The overall benefit is enhanced safety of nuclear power reactors.

DOE - Sandia National Laboratories

AlGaAs/GaAs RADIATION TOLERANT PHOTODIODE

Because of the detrimental effects of all types of radiation on photodetectors there has been a fundamental need for radiation tolerant optical detectors for operation in adverse radiation environments. During the 1981-87 time period Sandia Laboratory personnel were involved in development, characterization and technology transfer of an AlGaAs/GaAs double heterostructure photodiode which is more radiation tolerant than the commonly used silicon technology. This photodiode technology has been successfully transferred to both Honeywell Optoelectronics in Richardson, TX and to Ortel Corp., Alhambra, CA.

The development of the photodiode was undertaken following a systematic optimization of device design parameters using a computer code. Using the optimized design an intensive in-house development effort was undertaken using both liquid phase epitaxy (LPE) and molecular beam epitaxy (MBE) for device layer growths. Both types of photodiodes were extensively characterized before and after gamma, neutron and transient ionizing irradiations. This new photodiode structure was shown to be more resistant to all types of radiation than optimized Si photodiodes.

Subsequently the device design and processing techniques were transferred to the private sector. Sandia Laboratory personnel performed four key tasks to achieve the technology transfer: 1) identified sources in the private sector with semiconductor processing facilities of sufficient quality to successfully fabricate the device, 2) provided capacitance-voltage measurements on completed devices as a monitor of the active region material quality, 3) provided impurity doping profile measurements on material layer growths on uncompleted devices, and 4) provided radiation characterization of completed diodes. Since the device design calls for a thin, undoped active region, sources in the private sector capable of precisely controlled layer growths were required. The second and third tasks were required to provide information on the outdiffusion of impurities from the heavily doped heterojunctions and on the background doping density in the active region. The fourth task was necessary because required radiation facilities do not exist in the private sector.

It is expected that there will be a large number of general applications for this photodiode in radiation environments. The benefits of this technology transfer process lie in creating suppliers in the private sector to satisfy a broad range of demands for radiation resistant photodetectors.

DOE - Sandia National Laboratories

SUPERCONDUCTIVITY APPLICATIONS CENTER FOCUSES ON USE OF NEW SUPERCONDUCTORS

THE TECHNOLOGY

For 75 years, superconductivity has remained largely a scientific curiosity achievable only at temperatures near absolute zero. Until recently, applications of superconductivity were limited by the high cost of liquid-helium-based coolant systems. Last year's discovery of new, high-temperature superconducting materials may inaugurate developments that make superconductivity a broadly marketable technology.

To speed the development of superconductivity applications, President Reagan recently designated Argonne as the nation's Superconductivity Research Center for Applications. The laboratory will lead efforts to develop practical uses for new superconducting materials.

TECHNOLOGY RECIPIENTS

High-temperature superconductors could benefit energy production, electronics, transportation, medicine and research.

USES AND BENEFITS

The first high-technology uses could occur within five years: thin films for computer interconnections, more efficient electric motors, and improved magnets for medical imaging devices.

DOE - Argonne National Laboratory

NUCLEAR STRUCTURE AND DECAY DATA

The Isotopes Project of the Nuclear Science Division, in collaboration with an international data network, provides evaluated nuclear structure and decay data for the worldwide nuclear physics community. The primary purpose of this data evaluation effort is to aid nuclear structure physicists. However, these reference data include energies and intensities of radiation from radioactive isotopes, data that are essential for the medical use of these isotopes, and are invaluable sources of information for scientists probing new areas of research. In addition to its mass-chain evaluation, in 1986 the group published the Table of Radioactive Isotopes, a comprehensive volume of decay data intended primarily for applied users of nuclear data. The same data are also available via an on-line computer database.

DOE - Lawrence Berkeley Laboratory

RAPID BRAIN SCANNING RADIOPHARMACEUTICAL

The rapid brain scanning radiopharmaceutical, developed since 1982, is designed to measure regional blood flow in the human brain, and we have demonstrated its application in patients with stroke and Alzheimer's disease. We have designated this class of substituted amphetamines as IDNNA-type compounds; the patent for them was awarded in FY 87. The radiopharmaceutical is produced by an extremely rapid chemical addition of the radioisotope which allows radioisotopes with very short half-life to be used, reducing the radiation does to the patient, and repeat studies can be performed at short intervals. The IDNNA compounds are designed specifically to be labeled with isotopes for Positron Emission Tomography, for which we use iodine-122, with a 3.5 minute half-life, but they are also suitable for 13 hour iodine-123 for use with the clinically available SPECT imaging system. The iodine-122 is extracted from 20 hour venon-122, which can be made by a cyclotron and shipped to imaging centers not having cyclotron. We have initiated technology transfer to several companies, and we expect interest to increase as the anticipated move toward Positron Emission Tomography continues in Nuclear Medicine.

DOE - Lawrence Berkeley Laboratory

BUILDING ENERGY SIMULATION

DOE-2 is an LBL-developed computer program for simulating the hour-by-hour energy use of residential and commercial buildings. It is widely used by the building research and design communities in the U.S. and over 20 other countries to evaluate energy efficient technologies and design. During FY 1987, approximately 130 copies of DOE2.1C, the latest version of the program, were distributed by LBL and NTIS for implementation on mainframe computers in the public and private sectors. DOE-2 is also being made available by a private company in a version that will run on IBM-compatible personal computers. LBL continued quarterly distribution of the DOE-2 User News to about 200 subscribers. The User News features documentation updates and corrections, articles of interest to program users, an explanation of program bugs and their fixes, and documentation ordering information.

DOE - Lawrence Berkeley Laboratory

STEREOTACTIC HEAVY-ION BRAGG PEAK RADIOSURGERY

The program at Donner Pavilion has applied nuclear medicine research to the diagnosis and radiosurgical treatment of life-threatening intracranial vascular disorders that affect approximately one million Americans. Sterotactic heavy-ion Bragg peak radiosurgery, using narrow beams of heavy ions (helium), demonstrates superior biological and physical characteristics in brain over X-rays, gamma rays and protons, viz., improved dose distribution in the Bragg peak, sharp lateral and distal borders, and less multiple scattering and range straggling for the same residual range in CNS tissue. Examination of CNS tissue response and alteration of cerebral blood-flow dynamics related to heavy-ion Bragg peak radiosurgery is being undertaken using three-dimensional treatment planning and quantitative imaging utilizing cerebral angiography, computerized tomography (CT), magnetic resonance imaging (MRI), cine-CT, xenon X-ray CT, and positron emission tomography (PET). Also under examination are the physical properties of narrow heavy-ion beams for improving methods of dose delivery and dose distribution and for establishing clinical RBE/LET and dose-response relationships for human CNS tissues. Based on the evaluation and treatment with stereotactically directed narrow beams of heavy ions of over 250 patients, with cerebral angiography and CT scanning, and with MRI radiosotope scanning of selected patients, plus extensive clinical and neuroradiological follow-up, it appears that heavy-ion radiosurgery obliterates intracranial arteriovenous malformations or protects against rebleeding with reduced morbidity and mortality. This technology is being transferred to the general medical community.

DOE - Lawrence Berkeley Laboratory

SOL-GEL DERIVED BIOGLASS

A bio-active material that has the capability of replacing or repairing human bone and soft tissue. SDI - research at the University of Florida in materials processing technology for rapid fabrication of optical devices has led to a spinoff material with the appropriate chemical properties that make it bio-compatable with human tissue. Extension of this technology is expected in a host of applications for new types of bio-compatable prostheses for bone segments, inner ear ossicle bone replacements, dental implants, and numerous surgical applications.

DOD - Strategic Defense Initiatives Organization

HIGH SPEED, FAULT-TOLERANT COMPUTER APPLICATIONS IN MEDICINE

High speed computer processors and programs of the SDI Gallium Arsenide Multiple Instructions Per Second (MIPS) program are being made available to the medicine community through the Mayo Clinic to enhance the study of model molecular structures essential in the derivation of new designer drugs.

Computers used today in operating rooms may fail, with life-threatening and potentially fatal consequences. Applications of the SDI Gallium Arsenide Advanced On-board Signal Processor provides computing technology designed to degrade gracefully without total shutdown. Applications are being explored by the Mayo Clinic.

DOD - Strategic Defense Initiatives Organization

APPLICATIONS TO OPTHAMOLOGY AND EYE SURGERY

SDI technology for Optical tracking of ballistic missiles and warheads has potential application for tracking the rapid random movements of the eye to enhance diabetes-related eye surgery with lasers.

An integrated system of diagnostic lasers to measure aberrations in the cornea, an SDI developed, computer-based aberration differencing analysis program, and precisely controlled output to a thermal laser is being studied to plastically deform the cornea to allow a reshaping process (thermal kerotoplasty) that may drastically improve poor vision. This process is a dramatic technological extension of the currently used, but controversial radial kerotonomy process that originated in the Soviet Union.

The application of diamond crystal coating processes, developed for the protection of optics and coating of electronic circuitry under SDI programs, are being evaluated for producing microminiature instruments for eye surgery.

DOD - Strategic Defense Initiatives Organization

DIAMOND CRYSTAL COATING TECHNOLOGY

Developed under the SDI Diamond Technology Initiative Program for the coating and protection of mirrors, electronics and other devices in space, this new process for depositing thin layers of diamond crystal on surfaces has numerous potential applications:

1) Protection of eyeglasses, windows, mirrored surfaces
2) Surface hardening of cutting, grinding, manufacturing tools and machinery
3) Acoustical speaker applications-a technology spinoff that is currently being marketed by the Sony Corporation
4) Manufacture of microminiature surgical instruments from micro circuit technology, coated with diamond crystal to produce super sharp microsurgical instruments for eye surgery

DOD - Strategic Defense Initiatives Organization

SECTION J

OTHER MECHANISMS

ARGONNE RESEARCHER TAKES TOXIC GAS DETECTOR TO MARKETPLACE

THE TECHNOLOGY

Argonne National Laboratory's portable toxic gas detector, called a "Chemical Parameter Spectrometer", or CPS-100, could help save the lives of thousands of workers involved with the handling of toxic gases. The unique device can identify the type and concentrations of about 12 hazardous gases instantly. Weighing only 15 pounds, the portable battery-powered instrument can be used almost anywhere, and uses inexpensive, rugged, low-power sensors to do a job that formerly required a laboratory full of expensive equipment. Its ability to quickly analyze toxic gases in the field makes it an important tool for workers in today's high-technology society. While current models of the instrument can identify 40 chemicals, new versions are expected to handle up to 100 chemicals. The sniffer was the winner of a prestigious IR-100 award in 1984

TECHNOLOGY RECIPIENTS

One of the Argonne scientists, Dr. Joseph Stetter, has formed a company (Transducer Research Inc.--TRI) and has left the Laboratory to run the company. He has established an office and assembly shop, has received a contract from the Coast Guard Service to manufacture up to 50 instruments, and has prospects for orders from other sources. Part of TRI's research and development program is funded by SBIR grants.

In the fall of 1987, Stetter signed an agreement with ARCH to manufacture and sell a toxic gas detector developed while he was an Argonne employee. Stetter, who was the principal developer of the detector, set up an office and laboratory in a business incubator at Moraine Valley Community College, near Argonne. The advantages offered by the incubator, combined with multiple Small Business Innovation Research grants, gave TRI the boost it needed to license the technology for manufacture and sale. SBIR grants have helped TRI by providing the intellectual spark for several new product lines, as well.

USES AND BENEFITS

The potential market for the toxic gas detector is very large; it is believed that every fire department will want one to enable its firefighters to rapidly analyze toxic gases in buildings, vehicles, etc.

DOE - Argonne National Laboratory

INDUSTRIAL RESEARCHERS BENEFIT FROM AMES MATERIALS PREPARATION CENTER

THE TECHNOLOGY

The Ames Laboratory-USDOE has developed unique capabilities, expertise and facilities for the preparation and Processing of new materials. Ultrapure metals, single crystals, special alloys, and composites, which are not available from any other laboratory or commercial supplier, are being provided (at full recovery of government costs) to the industrial sector. Refractory metals and alloys, the rare earth metals, the transition metals, magnetic materials, superconducting composites, and high-strength normal conducting alloys are examples of the types of materials in which the Ames Materials Preparation Center (MPC) specializes.

TECHNOLOGY RECIPIENTS

The Ames materials preparation technology and the new materials for which Ames has developed processes have been transferred to innumerable recipients. Over 150 formal orders for materials are processed each year by the MPC from government, university and industrial laboratories. Some examples of recent industrial recipients include:

Anderson Physics Laboratory
AT&T Bell Laboratories
BELLCORE
General Motors Research Laboratory
GTE Laboratories
Hughes Aircraft
Magnequench
Nucor Corporation
Oxford Superconducting Company
Rockwell International
Supercon, Inc.
Thermoelectron Corporation
United Technologies
Universal Energy Systems

In addition to these industrial sector recipients, over 50 orders from U.S. universities were filled by the MPC during FY 1987; many of these institutions and companies have multiple interactions with the MPC.

USES AND BENEFITS

The materials and processes acquired from the MPC are used in a wide variety of research and product development programs. Respect for proprietary interests and information prevents any specific listing of these uses. It can be said, however, that the nature of these programs and of the companies involved are such as to ensure the enhancement of multiple technologies, the creation of new product lines, the growth and expansion of businesses, the generation of new jobs, and a positive economic impact.

DOE - Ames Laboratory

ASPIRE/ARCH

THE TECHNOLOGY

Argonne National Laboratory has developed a method for moving Argonne-developed inventions to private industry, combining systematic invention evaluation (ASPIRE) and a specially created corporation designed to commercialize selected inventions (ARCH).

ASPIRE: Argonne inventions are evaluated for technical feasibility and value to industry through a systematic process developed by Argonne's Technology Transfer Center. The process is known as ASPIRE (Argonne System for Patent and Invention Report Evaluation). Every Invention Report filed by Argonne employees is reviewed through this process, and formal recommendations regarding technical feasibility and market considerations are prepared. After a series of concurrence reviews, the recommendations are provided to the ARCH Development Corporation for further evaluation of market potential and commercialization. Inventors are notified which inventions have no commercial interest to ARCH so that they may seek rights to their own inventions if they desire.

ARCH: Under the implementation of Public Law 98-620 and a recently revised contract with the U.S. Department of Energy, The University of Chicago, as Argonne's operator, may title to inventions made under federal funding at Argonne (as well as the University). Inventions selected through ASPIRE and acquired by the University are transferred to the Argonne National Laboratory/ The University of Chicago Development Corporation (ARCH), which licenses or otherwise commercializes them. ARCH was formed by Argonne and the University in 1985 as an Illinois not-for-profit corporation. Revenues generated by ARCH will be used for operating expenses , awards to inventors, and further development of inventions made at Argonne and the University of Chicago.

TECHNOLOGY RECIPIENTS

The recipients of the ASPIRE/ARCH method are industry, individual inventors, and the Laboratory.

USES AND BENEFITS

Since March 1984, when ASPIRE was initiated, about 275 Invention Reports, some stemming from as early as 1981, have been reviewed. In FY 1986 alone, more than 90 Invention Reports were reviewed. About 25% of these were referred to ARCH for further consideration.

The ASPIRE/ARCH system is working well. Two technologies--a helium-dilution refrigerator and a toxic gas detector--have been licensed through ARCH, and licensing negotiations related to several other important Argonne inventions are well underway.

DOE - Argonne National Laboratory

THE AFFILIATES PROGRAM: CAPITALIZING ON ARGONNE'S LEAD IN SUPERCONDUCTIVITY

THE TECHNOLOGY

For 75 years, superconductivity has remained largely a scientific curiosity, achievable only at temperatures near absolute zero. Until recently, applications of superconductivity were limited by the high cost of liquid-helium-based coolant systems. Last year's discovery of new, high-temperature superconducting materials may inaugurate developments that make superconductivity a broadly marketable technology. Argonne is a leader in high-temperature superconductivity, with nearly 100 scientists working on all aspects of superconductivity, from basic research to fabrication to economics.

With ARCH Development Corporation, Argonne has established an Affiliates Program in Superconductivity to assist in transferring the results of this critical research to industry. The ARCH/Argonne Affiliates Program is the first to take advantage of world-class scientific expertise and facilities combined with the business acumen of a not-for-profit corporation linked to a prestigious business school. This unique combination will allow Affiliate members the opportunity to establish a strong position in the rapidly developing field of superconductivity. The governing boards of ARCH, Argonne, and the University of Chicago include a number of prominent industrial leaders whose counsel will be invaluable to the Affiliates program.

TECHNOLOGY RECIPIENTS

Large and small businesses interested in being at the forefront of superconductivity research.

USES AND BENEFITS

The ARCH/Argonne Affiliates program is designed to provide industry firsthand access to Argonne's cutting-edge research in superconductivity. This close interaction will allow industries to assess the market impact of this new technology and to determine the match between their corporate aims and Argonne's research directions. Close relationships can be established early to facilitate subsequent working arrangements, which can include joint ventures, consortia, or one-on-one cooperative research and development agreements. The Affiliates fee structure has been designed for both large and small businesses. In addition, an Argonne membership has been established for those who wish limited participation in follow-on research.

DOE - Argonne National Laboratory

TECHNICAL VOLUNTEERS/INTERGOVERNMENTAL PERSONNEL ACT ASSIGNMENTS

THE TECHNOLOGY

The Naval Underwater System Center (NUSC) has developed and used extensively two mechanisms to transfer Federal technology to State and local governments and industry. The Center designed and established the first Technical Volunteer Service (TVS) in a Federal laboratory in which NUSC professional staff volunteer their time and technical expertise to provide information and assistance to State and local governments and nonprofit organizations. The Center uses the mobility provisions of the Intergovernmental Personnel Act (IPA) of 1970 to initiate personnel exchanges between NUSC and State and local governments and academic institutions.

TVS: NUSC personnel design or adapt municipal and intermunicipal communications systems and public address systems in town halls and schools; adapt hydrophones to unusual uses for educational experimental purposes; unscramble evidentiary tape recordings; evaluate computer and energy systems requirements for cities; evaluate the need of the handicapped of all ages and retrofit equipment and develop computer software to meet those needs.

IPA: NUSC professional staff have been assigned in technical advisory capacity-building position in State and local governments in the Northeast. Assignments have been diverse both in nature and focus. An assignment to a state municipal league stimulated private industry to approach the municipal market; to a state legislature resulted in translation of scientific data into more informed legislation; to a consortium of six midwestern cities resulted in the acquisition and administration of a cable television franchise, which improved communications among the cities and promoted governmental, educational and public access use of the cable. A NUSC staff member was assigned to the New York City Police Department Motor Transport Division. He designed an automated fuel monitoring system for the Department, wrote the specifications, evaluated bids, supervised the installation, and critiqued it for NYCPD.

TECHNOLOGY RECIPIENTS

The recipients of the NUSC program are State and local governments, nonprofit organizations serving the handicapped, and industries which can meet the NUSC-identified needs of these organizations.

USES AND BENEFITS

TVS participants developed computer software which enables young adults suffering from cerebral palsy to improve their fine and gross motor control. The New York City Police Department fuel monitoring system resulted in savings of approximately $2 million in its first year of operation, making the payback time of startup and capital costs less than one year. The system has been expanded city-wide, and replicated in other state and municipalities. Commercial organizations have developed systems to meet the demand.

DOD - Naval Underwater Systems Center

HOT-AIR SOLDER LEVELER

A hot-air solder leveler invented at Sandia National Laboratories in the early 1970s revolutionized the fabrication of printed wiring boards. The leveler has cut circuit board processing time by 90 percent and spawned three new industries generating over $150 million annually in sales.

In 1969, the new process of reflow soldering needed a method for applying molten solder thicker than was possible with plating or liquid leveling. Early experiments showed feasibility, and the idea was presented by T. A. Allen in 1969 for funding.

In 1970-71, implementing of ideas began, and the prototype hot-air leveler was developed. The first paper was presented by Allen in October 1973 at the California Circuits Association in Anaheim. Over 300 inquiries were received, and three companies were licensed to produce the machine. The machine gained wide use in Europe before the United States changed over to the new process.

More than ten companies have produced the leveler (eight of them also supplying chemicals) and four specialty companies are hot-air leveling millions of boards annually as a contract service to PC users in 20 "solder station" outlets. Two new machine producers (in Germany and England) offered levelers in 1986, and one in the United States was added in 1987.

The process has accommodated the following new PC designs: flex circuits, multiwire, rigid flex, vapor phase soldering, and surface mount components, among others. Modified machines are used for terneplate products.

DOE - Sandia National Laboratories

LAMINAR AIR FLOW CLEAN ROOM

Willis Whitfield, at Sandia National Laboratories, conceived and developed the laminar air flow clean room--the uniform flow of filtered air which removes virtually all airborne contamination. This technological advance created a new U.S. industry, now a $300 million-a-year business.

In 1959 Whitfield was asked to investigate the inadequacy of clean rooms to maintain cleanliness levels for Sandia's weapon components, particularly in the production phases. Clean rooms were essentially the same as the ones developed during World War II to assemble gyroscopes and bombsights. High efficiency filters in conventional ventilating systems, constant cleaning of the room to remove contamination, and special clothing for workers were ineffective measures for the assembly of delicate weapon components.

In 1961 Whitfield designed the clean room based on an elegantly simple idea: "sweep" the room with a uniform flow of filtered air that removes virtually all the airborne contamination in the room. The design proved so efficient that a large downflow clean room was soon built at Sandia. In January of 1962 the first significant item of technology was publicized in a full-page story in the Lab News, Sandia's employee newspaper, and the news release was issued later that month. Whitfield presented a formal paper on his clean room work in April 1962 to the National Meeting of the Institute of Environmental Sciences in Chicago. Although a number of publications across the country had picked up the story in the early months of 1962, the big payoff came in April when Time magazine ran a story on Sandia's clean room breakthrough. This article quickly brought the new technology to the attention of government and industry, both in the United States and abroad.

Industry quickly adopted the laminar clean room design. Whitfield's original 8-by-10-foot prototype was converted by Western Electric into a 20,000-square-foot clean room for the assembly of pushbutton telephones; RCA assembles television picture tubes in a facility of the same size at Lancaster, Pennsylvania. The laminar flow concept resulted in an environment 100 times cleaner than conventional clean rooms of the era, and soon became the basis for Federal Standard 209 (Clean Room and Work Station Requirements, Controlled Environment).

Laminar flow clean rooms affected a tremendous number and variety of industries, most notably microelectronics fabrication and pharmaceuticals. The clean room concept has also had a major impact on the medical field. Hospital pharmacies use "clean benches" (an adaption of the clean room concept) for mixing machines. Employing the air hood apparatus, also invented by Whitfield, the clean bench applies laminar air flow principles to a limited work area. Penicillin particles in the air had been getting mixed with other drugs and the clean bench put an end to that kind of contamination. In January 1966, the first operating room in the United States to be converted to laminar air flow was at Bataan Memorial Hospital (now Lovelace Medical Center) in Albuquerque. In addition to hospitals, other organizations were affected as well: aerospace contractors, biological and food processing concerns, and more.

DOE - Sandia National Laboratories

DRILL BIT TECHNOLOGY

Sandia National Laboratories financed the design and test of a new drill bit for intermediate hardness rock, as well as designed a diffusion bonding process for diamond cutters. Sandia developers transferred to a new company.

One example of the assorted drilling and logging technology developments accomplished through Sandia over the last 14 years is a polycrystalline diamond (PCD) compact drill bit. The PCD compact technology was developed by General Electric during the early 1970s with a primary application in machine tools. Sandia recognized this synthetic diamond technology in the middle 1970s as having a potential drill bit application. Sandia worked with G.E. in furthering the development of the PCD compacts themselves, developed a diffusion bonding process for reliably attaching the compacts to a steel or tungston carbide stud, developed design codes for optimally locating the PCD-faced studs on a drill bit face, and assembled a set of conceptual designs and specifications.

Based upon these design specifications, Sandia transferred the technology by requesting from industry (through a funded request-for-proposal process) their best designs for this new concept. Sandia worked closely with companies having the winning proposals to give them the benefit of its design and test/evaluation facilities and experience.

The result of this endeavor was that by the early 1980s up to fifteen bit companies (many of them small) were manufacturing and marketing this technology for use in sedimentary basins with soft to medium-hard formations. Tests and experience indicated that, on average, penetration rates were double those of the conventional, roller-cone bit technology.

Today, every major bit manufacturer markets their version of this bit technology. When used in the appropriate formations, the technology alone can reduce total drilling costs by up to 10%. As the use of downhole drilling motor technology improves (high speed drilling) the PCD drill bit will become even more valuable. The projection of cost savings and/or recovered energy value returned over the next decade is conservatively estimated to be in the multibillion dollar range.

DOE - Sandia National Laboratories

FIELD NEUTRON ACTIVATION ANALYSIS

The U.S. Geological Survey also developed and has patents on the high-resolution bore-hole gamma-ray spectrometer probe that has been adopted by industry. The probe uses either a Californium-252 neutron source or miniature accelerator. The technique is described in a number of publications, but a particularly thorough review is given by F.E. Senftle, 1980, Application of gamma-ray spectral analysis to subsurface mineral application, in Short Course in Neutron Activation Analyses in the Geosciences (G.K. Muecke, editor): Mineralogical Association of Canada, p.211-254.

DOI - U.S. Geological Survey

ELECTRONIC IDENTIFICATION SYSTEM BENEFITS SHIPPING, RAIL AND VEHICLE INDUSTRIES

THE TECHNOLOGY

Electronic identification was developed from research which initially began at Los Alamos National Laboratory. The original research conducted at Los Alamos National Laboratory was funded by the Animal Plant Health Inspection Service of the U.S. Department of Agriculture (USDA). The funded research was to provide the USDA with three interactive technologies, one of which was the electronic identification system. The system was developed to aid in obtaining unique, unambiguous, and computer compatible identification of animals without the need to restrain animals.

THE TECHNOLOGY RECIPIENTS

AMTECH Corporation was formed to explore the potential industrial applications of the electronic identification system developed at Los Alamos National Laboratory. The corporation had its initial beginnings in the research and development project which began in 1972 at Los Alamos. The original technology was transferred from the Laboratory to AMTECH, with all patent rights becoming property of AMTECH in 1984.

AMTECH has made significant technological changes to the original electronic identification system developed at Los Alamos so that it can be used by the cargo transport industries, specifically the maritime shipping industry, rail industry and vehicle industry.

USES AND BENEFITS

AMTECH's technology was named one of the 100 most significant technical developments by Industrial/Research Magazine in its prestigious IR-100 competition in 1978. AMTECH is able to custom-build its system to meet the specific needs of the customer. This type of interaction between supplier and consumer ensures that the user's needs are being met. Although there are other manufacturers of electronic identification systems, none of the current suppliers have been able to meet AMTECH's technology standards for commercial use of the system. AMTECH's system has capabilities to long standoff requirements and rapid data acquisition, neither of which have been met by other system manufacturers. AMTECH's system meets or exceeds most of the requirements for electronic identification applications needed in the transportation industry, both in U.S. and foreign markets.

Because AMTECH is able to custom-build a system to meet the specific needs of a customer, the unit price of each system varies. AMTECH is currently in the development stage, and most revenues up to this point have been generated from the sale of test systems to industrial entities. The market outlook for AMTECH's electronic identification system is difficult to estimate, but from all indications, there is a strong market demand for AMTECH's technology. AMTECH currently employs 45 employees, and with the continued trend in growth, expectations are that AMTECH could employ as many as 100 employees by the end of 1988.

DOE - Los Alamos National Laboratory

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If you would like more information regarding the FLC, please fill out the information below, carefully tear-out this page (or make a copy) and return it to the FLC Administrator's Office.

__ Yes, I would like additional information on the FLC.

__ Please add me to your general mailing list so that I may receive the Newsletters, meeting announcements and special mailings.

NAME: ______________________________ (____)______________
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REPRESENTING: ____

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REPORT TO THE CONGRESS
AND
THE FEDERAL AGENCIES

Activities of the
Federal Laboratory Consortium for Technology Transfer
Pursuant to the Federal Technology Transfer Act of 1986

April 25, 1988

Report submitted by:

Dr. Eugene E. Stark, Jr.
Chairman

EXECUTIVE SUMMARY

The term "technology transfer" includes a range of formal and informal cooperations between Federal laboratories and US businesses, universities, State and local governments, and the Federal agencies. The purpose is to strengthen the nation's economy by enhancing the application of Federal laboratory technology and resources to these groups' needs and opportunities. Product improvement, service efficiencies, improved manufacturing processes, joint development to address government and private sector needs, and the development of major new products for the international marketplace, are examples of proven technology transfer results.

The Federal Laboratory Consortium for Technology Transfer was organized in 1974 and formally chartered by the Federal Technology Transfer Act of 1986 to promote and to strengthen technology transfer nationwide. Its members include all major Federal laboratories and centers and their parent agencies.

In its first year under this Act, the Federal Laboratory Consortium (FLC) has made significant progress in building a stronger network of cooperation among the Federal laboratories and in enhancing technology transfer nationwide. Emphasis has been on developing person-to-person contacts that are essential to technical cooperation; on development and replication of promising models for technology transfer; on assistance to the laboratories and agencies; and on the promotion of nationwide technology-based cooperation.

Major accomplishments include:

- Development of a resource database and electronic mail infrastructure for interlaboratory cooperation and communication;
- Establishing a Clearinghouse that assists American organizations in finding specific laboratory technical contacts;
- Training of laboratory technology transfer personnel in skills required to develop agreements permitted under the Technology Transfer Act;
- Successful technology initiatives with industry, small business, universities, and State and local governments;

- Significant expansion of cooperation with State-level programs;
- Initiation of a diversified approach to the marketing of technology transfer and cooperation to the private and public sectors, through presentations, publications, personal contact, and through professional and trade associations;
- Completion of a strategic planning process, which has led to a strengthened Consortium Committee structure and positions the Consortium to support all national efforts; and
- Increased activity in the six Consortium geographic regions, including the naming of advisors from the client communities.

The Consortium's greatest strengths are:

- The dedicated efforts of individual Representatives acting for their laboratories and Agencies;
- A highly flexible organization that can seize rapidly on new opportunities;
- The Consortium Representatives' breadth of contacts - geographically, professionally and personally; and
- Association with the Federal Government's massive research and development resources.

The greatest barriers to fuller public and private sector utilization of the nation's Federal laboratory assets are organizational cultures and individual attitudes; but these provincial tendencies are abating.

The Consortium is very optimistic that technology based cooperation among its members and industry, the State and local sectors, and academe will demonstrate escalating benefits to our society.

The FLC leadership, its committee membership and its Agency Liaison Group are listed in Appendix II.

Reported by:

Eugene E. Stark, Jr.

Dr. Eugene E. Stark, Jr.

Chairman

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NATIONAL INITIATIVES WITH THE PRIVATE AND PUBLIC SECTORS

INTRODUCTION:

The Federal Laboratory Consortium initiates national programs that are beyond the scope of individual laboratories or agencies. In most of these initiatives, the Consortium represents the broad resources necessary for substantial progress. Another approach with nationwide impact is monitoring the success of individual laboratory initiatives and facilitating their rapid replication.

INDUSTRY:

The larger companies have ample resources and wide interests that can facilitate a broad range of long-term relationships with the Federal laboratories. The strategy for developing this opportunity is to approach individual companies and their trade associations directly at both executive and technical levels.

The Consortium was approached by the Industrial Research Institute (IRI) with the compelling need for linking American industry with the government's manufacturing technology programs. The result was a national conference cosponsored by the Consortium and the IRI, hosted by the Wright Aeronautical Laboratory. The conference focused on computer-integrated manufacturing, with presentations by representatives of the three military services, the National Bureau of Standards, the National Aeronautics and Space Administration and the Department of Energy. There were representatives from State and local based programs, academe and from more than fifty American companies who overwhelmingly rated this conference extremely valuable in forging relationships with the government technology programs. They also indicated a strong interest in similarly-focused initiatives in other areas of manufacturing technology.

Since 1982, the FLC has sponsored a series of eight intensive Technology Transfer Conferences designed to spark industrial interactions with participating Federal laboratories.

In 1987, twelve Federal labs presented some of their newest and most promising technologies to representatives of 39 major companies. The practical one-on-one sessions built into each program have led to substantive collaborations. The next conference in this series is scheduled for December in Atlanta.

A similar conference, sponsored by the Association for Chemical Technology Transfer, was organized by the representative from the Food and Drug Administration's National Center for Toxicological Research. At that meeting seven Federal laboratories met with 27 interested technical representatives from the chemical industry.

To support the July, 1987 White House Conference on Applications of Superconductivity, the Consortium compiled a description of laboratory activities in this area. The document was in high demand at the Conference and has since been widely disseminated.

The Consortium has recently begun approaching corporate CEOs individually to help develop top-level support and encouragement for cooperation with Federal laboratories. The test case went well and encouraged the Consortium and industry representatives to expand this effort.

The Consortium's Washington Representative organized a subcommittee of the Industrial Research Institute (IRI) to increase interactions with industry. Marketing the concept of cooperation was identified as the central challenge. Important committee suggestions include a recently published document on laboratory technology transfer successes, and an industry survey that will be conducted soon by the IRI.

SMALL BUSINESS:

The importance of small business to the nation's competitive position and job creation is well understood. The diverse and disaggregated nature of the small business community poses a unique challenge in developing national initiatives. Our approach has focused on working with State-level programs, participating in government innovation workshops, and replicating the successful experience of individual laboratories. Recently the Consortium has expanded upon this approach by activating the Small Business Subcommittee to develop and coordinate small business programming on both regional and national levels.

The Consortium continues to share resources and work with the Ohio Technology Transfer Organization. This experience has enabled us to make contributions to other emerging programs in other States. A recent example is the formation of Centers for Innovative Technology at the community colleges in Virginia. The Consortium assisted in training the directors of these new Centers, specifically on Federal laboratories as a resource.

The Consortium's Clearinghouse has been particularly valuable to small businesses having specific technical needs but who are unsure of which laboratory to contact. The Clearinghouse is described later under "Strengthening Technology Transfer."

Consortium representatives participated in the National Science Foundation's Federal High Technology Conferences that promote participation in the Small Business Innovative Research program. As a result, more small businesses are seeking cooperation with Federal laboratories in planning and executing their research.

The Consortium has recently agreed to work with the Oklahoma State Department of Vocational and Technical Education (VOTECH) in a program linking Federal laboratories to small businesses within Oklahoma. Orientation of the VOTECH field staff to Consortium network resources is planned prior to laboratory presentations in identified areas of interest. This will be the first State-sponsored program focused on Federal laboratories, and in a State with no large laboratories. The program could be a model for future activities in other States.

Consortium cooperation has begun on a trial basis with the Florida High Technology Industry Council after they expressed interest in communicating specific technology opportunities to Florida businesses.

STATE AND LOCAL GOVERNMENT PROGRAMS:

These governmental bodies are responsible for a significant portion of the services provided to citizens; and they have been direct users of laboratory technology. In many instances, these governments have effective programs to assist resident companies, to which Federal laboratory technology contributes. Nonprofit geographically-based programs are also important in technology transfer.

In Pennsylvania, the PENNTAP program uses Consortium resources to its benefit, and the Ben Franklin Partnership, University City Science Center, PENNTAP and EDA are cooperating to review and target Federal laboratory technologies for use by local businesses.

The New York State Industrial Extension Service has also recently begun working with the Consortium.

Through the NASA Industrial Application Center (NIAC) Affiliates Program, small businesses can reach technical contacts in NASA and other federal laboratories. The Affiliates Program connects individual State programs from 16 western States into the searching and networking capabilities of NIAC. The Consortium member laboratories address small business needs in other ways, including local technical support, workshops, and other meetings that help small businesses work with, and benefit from, the government laboratories. The Consortium/NIAC activity has led to the establishment of a similar program between the Consortium's Southeast Region and the NASA-Technical Applications Program at the University of Kentucky.

The Consortium participated with the California Engineering Foundation in a forum on facilitating technology transfer between Federal laboratories and the California private sector. Follow-on activities are expected to include government/industry workshops on specific technologies available for transfer.

In Maryland, Consortium representatives have helped make specific plans with the Prince Georges County Economic Development Corporation and the State to include Federal laboratories in their activities.

Programs in Mississippi such as the Institute for Technology Development and the Gulf Coast Breeder, are working with the Consortium to develop links to the Federal laboratories.

Additional cooperative efforts in Alabama, Florida, Ohio, Texas, and Oklahoma are described elsewhere in this report.

UNIVERSITIES:

Numerous opportunities are being examined for Federal laboratory cooperation with universities in their research and education, and in their community-service functions.

The Consortium's University Interaction Subcommittee is an outgrowth of an earlier initiative to develop nationwide contacts with universities. This group has provided advice on the national infrastructure required for productive relationships with the university community. The infrastructure under development is primarily a directory of laboratory resources and interests.

A survey has been made of university technical expertise, which will be available for use by the Federal laboratories. The results of this survey will assist and encourage the laboratories to broaden their cooperation with universities nationwide.

The Consortium signed a Memorandum of Understanding with Oak Ridge Associated Universities (ORAU). This agreement with the 49 university members will involve joint workshops and marketing by ORAU of the concept of cooperation between universities and Federal laboratories.

STRENGTHENING TECHNOLOGY TRANSFER AS A NATIONAL RESOURCE

INTRODUCTION:

Technology transfer evokes a variety of challenges to achieve what is, in effect, a cultural revolution. We in the government sector expect diverse institutions and individuals to cooperate. The agencies and laboratories are expected to initiate and negotiate challenging contractual and financial issues, and to do so rapidly. One of the Consortium's primary responsibilities is to develop the infrastructure and national interest for cooperation between the Federal laboratories and the public and private sectors.

REGIONAL EMPHASIS:

The Consortium's six geographic regions are the backbone of its national networking. The regions have developed advisors from the user communities, as suggested by the Technology Transfer Act of 1986. Financial support for regional activities could not begin until FY 88 because of the receipt of reduced operating funds late in FY 87. Each region, however, has continued its development:

Northeast: Has developed cooperation with New York's Industrial Extension Service and Technical Development Organizations. It is also setting up an interlaboratory forum on the development of Cooperative R&D Agreements.

Mid-Atlantic: Has begun an initiative with economic development organizations in the region and instituted training on intellectual property management.

Southeast: Has developed numerous working relationships with regional groups, e.g. the Top of Alabama Council of Governments and the NASA Technology Application Program at the University of Kentucky.

Mid-West: Cooperated in a 5-State Midwest Technology Forum that shared information on technology-based initiatives.

Mid-Continent: Assisted in development of local technology transfer relationships between San Antonio and a local laboratory.

Far West: Developed relationships with State organizations in the region through the NASA-IAC Affiliates Program, and is working with the California Engineering Foundation.

WASHINGTON D.C. REPRESENTATIVE:

The Washington DC Representative was named in April, 1987. Primary emphasis throughout the year has been on awareness raising activities to promote utilization of the Federal laboratory system by American industry, State and local economic development groups, and the public at large. Professional and trade associations have been contacted and a series of new initiatives has been launched to effectively bring broad segments of the private sector into constructive interaction with the Federal laboratories.

Liaison between the FLC and national leaders has been strengthened. A new initiative involving the placement of experienced industry personnel on short term assignments in selected federal laboratories to catalyze technology transfer (the Ferret Program) is in the final planning stage. Another initiative is to explore interest in the creation of a "Federal Research and Development Institute," which would link top-level Federal laboratory directors across all agencies into an information exchange, learning and sharing fellowship, which could then interface with private sector R&D leadership.

BUILDING LABORATORY INFRASTRUCTURE:

The Consortium offers the laboratories assistance in improving the skills of their technology transfer personnel and in improving their internal support for technology transfer.

Transfer Methods: Through its organized semi-annual meetings, the Consortium provides exposure for technology transfer officials to a variety of working cooperation models, with the opportunity for in-depth assistance. Recent topics have included: Cooperative R & D agreements; Patent Licensing; Enrichment of Pre-College Education; Commercializing Technology; State Collaboration with Federal Laboratories; Developing New Technology Venture Opportunities; Regional Technology Development Programs; Linking Federal Programs to State Economic Development; State Legislative & Executive Perspective on Economic Development and Industry's Role; Technology Transfer Broker Organizations; and Industry/Laboratories Consortia.

We have begun to see additional benefits from interagency networking. For example, an Army Laboratory seeking to license a technology applicable to the agriculture industry, was easily able to obtain assistance from the Department of Agriculture.

Training: Legislative changes have created a strong demand for training of technology transfer professionals. In addition to presentation of training courses on patent licensing and on commercialization of technology from the business viewpoint, an overall training strategy has been developed. Based on a survey of Consortium representatives, a priority list of needs has been developed, and the most pressing are being addressed immediately. This training is being coordinated with the work of the Interagency Working Group that has developed model agreements under the Technology Transfer Act. Training at the next meeting in May will be offered in two areas: first, an introductory, certificated class for electronic mail use; and second, a session on intellectual property and cooperative agreements in the rapidly changing world of technology transfer. All training is formally evaluated by Consortium members. The results of the evaluations are used to help define priorities in the Consortium training plan.

Awards: In 1984 the Consortium established annual Awards for Excellence in Technology Transfer. They are made to recognize and encourage extraordinary efforts in technology transfer. These awards are available only to individuals whose job assignment is not technology transfer, thereby reinforcing the emphasis on direct person-to-person cooperation. These FLC awards have become recognized by the laboratories and agencies as both prestigious and productive. The 1987 awardees are listed in Attachment I.

DEVELOPING A NATIONAL COMMUNICATIONS INFRASTRUCTURE:

An important national effort by the Consortium is the development of efficient communications among laboratories. As required by the Technology Transfer Act, electronic means for supporting this network have been developed.

Electronic Mail and Resource Directory: At present 61 laboratories and 11 allied organizations have been linked by an electronic mail system characterized by simplicity, efficiency and a friendly in-house system manager. A Resource Directory, a keyword-based listing of laboratory expertise, now covers 135 laboratory facilities.

Clearinghouse: The required Consortium Clearinghouse was established in July, 1987; it puts a requestor in touch with one or more key Federal laboratory staff. The Clearinghouse uses the Resource Directory to find the most likely laboratories to "match" with the requester, then uses personal contact with those laboratories' technology transfer offices to identify the key technical individual. Through February, 1988, the Clearinghouse had responded to inquiries from 28 States from the following sectors:

Large businesses	48%
Small businesses	38%
Local government	9%
Universities	3%
Others	2%

Of these inquiries, 73% cited a specific technical interest, with the remainder requesting general information.

PROMOTING TECHNOLOGY TRANSFER:

Many organizations are unaware of the availability and value of Federal laboratory technology transfer. Both awareness and interest need to be developed further through an extended effort.

As noted earlier, the Consortium was advised by industry representatives to document prior and ongoing technology transfers as a vital marketing aid to industry. Our response was a recently published report titled "Putting Technology to Work". The report provides 138 examples from 31 laboratories, and should be a valuable marketing tool. A copy of this report is included as Attachment II.

In cooperation with the Strategic Defense Initiatives Organization and the Los Alamos National Laboratory, the Consortium cosponsored a workshop with professional societies and trade organizations. As a result, we are now working to develop methods by which these organizations can encourage their member companies and professionals to work with Federal laboratories. The American Chemical Society, the American Society of

Mechanical Engineers and the Aerospace Industries Association have specific projects under way.

Consortium leaders have recently begun meeting with corporate CEOs on an ad hoc basis, to promote directly the benefits of collaboration with the Federal laboratories.

SPECIAL ORGANIZATIONAL COOPERATION:

The Consortium has concluded memoranda of understanding with several organizations for cooperation in technology transfer:

National Bureau of Standards (NBS): delineates the organizational relationship required by the Technology Transfer Act.

NASA - Technology Utilization Program: provides an umbrella understanding between NASA Technology Utilization activities and the FLC, especially relating to NASA Industrial Applications activities.

NASA - Industrial Applications Centers: builds on the NASA umbrella agreements and provides for regional cooperation in responding to the technology needs of the NIAC clients. Two regional agreements have been signed; in the Southeast and Farwest Regions.

Oak Ridge Associated Universities: to encourage 49 colleges and universities to work more closely with Federal laboratories.

Building Research Board, Public Facilities Council, National Academy of Sciences: to provide assistance and expertise to State and local governments on the leading edge of construction technology.

National Technical Information Service: formalizing the linkage required under the Stevenson-Wydler Act and the Technology Transfer Act.

U.S. Conference of Mayors: provides formal Consortium linkage to U.S. cities through the Conference of Mayors.

STRATEGY DEVELOPMENT:

Following passage of the Federal Technology Transfer Act of 1986, the Consortium felt it was important to develop a strategic plan. This process was completed in October, 1987 and a copy of the plan is provided as Attachment III.

DEMONSTRATION PROJECT

As required by the Federal Technology Transfer Act, a demonstration project has been awarded to a nonprofit organization. The Utah Research and Education Foundation project will match available technologies from three laboratories with industry interests in a data base covering over 1000 companies. The three laboratories are DOE's Lawrence Livermore National Laboratory, the NASA Ames Research Center and the Naval Civil Engineering Laboratory. Experience in this project may point the way toward an effective method for identifying technical opportunities and communicating them to interested organizations.

FLC ADMINISTRATION AND EXPENDITURES

The Consortium appreciates the diligence of the National Bureau of Standards in collecting the set-aside payments required by the Technology Transfer Act, and particularly the Bureau's willingness to provide advance funds in anticipation of these set-aside receipts.

The set-aside payments for FY 87 are indicated in the Appendix. In addition, individual laboratories transferred funds in the amount of $103,000 to support Consortium operations during FY 87. Details of the Consortium's expenditures are given in the Appendix. The expenditures are less than the receipts for two reasons: a) The set-aside payments were made, on average, during the last quarter of FY 87, so prudence dictated a lower spending rate; and b) the competition process for selecting support subcontractors (administered by member laboratories at the Consortium's request) was not completed until well into FY 87.

As anticipated in the legislative history of the Technology Transfer Act, the Consortium selected a Washington, DC Representative, a rotational position, based on a national search process. Mr. Lee Rivers, formerly Director of Planning at the Allied-Signal Corporation and IRI Fellow in the Office of Science and Technology Policy, assumed this position in April, 1987.

PLANS

Earlier sections of this report indicate plans to strengthen each aspect of technology transfer, both directly and through infrastructure development. Particular emphasis will be in four areas:

1. STRENGTHEN REGIONAL ACTIVITIES:

Beginning in FY 88 funds are being dedicated to regional programs. The six Regions anticipate different emphases, to build a more diverse base of experience. Activities will include facilitating transfers through regional workshops; networking with regional groups; encouraging stronger technology transfer postures by individual laboratory directors; facilitating a broader range of contacts; and cooperation with State organizations to market technology transfer to small businesses in a manner consistent with the Consortium's limited resources.

Small business initiatives include: information resource training; referral service at the regional level through an IPA placement from a local economic development organization; and development of working linkages with State-based small business associations.

2. TRAINING:

Based upon existing priorities, the Consortium will plan and execute an aggressive training program aimed at specific needs of laboratory technology transfer personnel. Wherever possible, training will be based on actual experiences of laboratories that break new ground. Individual laboratories are now preparing videotapes on those technology transfer processes where they have special expertise, for use by other laboratories and in FLC meetings for practical training. All available training materials are being systematically collected and evaluated for use by Consortium members.

3. PROMOTION OF TECHNOLOGY TRANSFER:

This will remain the key challenge to effective Federal laboratory technology transfer for several years. The Consortium will continue to expand its work in personal contacts, cooperation with key societies and associations, and preparing supporting documents. These efforts will support broad adoption of technology transfer as a tool in American commerce, and support agency and laboratory transfer programs. Well-documented information on successful transfers and on barriers can help policy makers in industry, academe and government develop sound decisions.

4. AGREEMENTS LIBRARY:

As individual laboratories gain experience in all aspects of licenses and cooperative R&D agreements, copies of the agreements and information on their development process will be maintained to assist all laboratories.

ISSUES

The timely transfer of Agency set-aside funds to the National Bureau of Standards for FLC use remains a problem even in the second year of this program. The Consortium's prudent financial planning has accordingly stretched out implementation of its activities and initiatives.

As more laboratories begin to develop cooperative agreements under the Technology Transfer Act, the timeliness of review and approval cycles rapidly increases in importance. In this period of intense international competition, rapid knowledge transfer and technology commercialization are essential to the Nation's competitive stance. The approval process for licenses and cooperative agreements is strengthening teamwork between laboratories and their agencies; the need for accelerated movement of technology reaffirms the requirement for rapid decision making.

The importance of computer software is becoming increasingly evident in the technology transfer arena. At present, there appears to be no government-wide mechanism to provide preferred access for American organizations over foreign competitors in the use, adaptation or distribution of much software developed at Federal expense; similarly, the ability to transfer software selectively to private companies may be required to justify their investment in documentation and support.

Although the situation is changing, the independent attitude of much of American industry still presents an obstacle to the exploration of cooperation opportunities. National leaders could have an important impact on this barrier through their encouragement, statements and actions.

APPENDIX I

FISCAL 1987 FINANCIAL SUMMARY
FEDERAL LABORATORY CONSORTIUM FOR TECHNOLOGY TRANSFER
FY 1987 EXPENDITURE REPORT

PROGRAM ELEMENT	EXPENDITURES
Administration and Management	
Executive Management	$ 37,000
Operations Management	103,713
Program Planning	22,951
Program Control	3,393
Washington, DC Representative (1)	81,200
Operations and Member Services	
Meeting support	33,560
Training	6 ,521
Communications	14,398
Clearinghouse (2) and Resource Directory	61,463
Invited Travel	2,475
Outreach Program	
Outreach Materials	33,012
Exhibits	8,219
General Support	11,494
Demonstration Project (3)	22,500
Regional Support (4)	0
TOTAL	**$ 441,899**

Note that expenditures are reported based on the FY 87 period of performance rather than on accounting entries or payments related to the Government's fiscal year.

NOTES:

1) Covers 6 months of operation.

2) Covers Directory development and 3 months of operation of the Clearinghouse.

3) Five percent mandated set-aside.

4) Due to late receipt of Agency set-aside funds, budgeted support to regional operations was not initiated in FY 87.

1987 SET-ASIDE RECEIPTS

The National Bureau of Standards reports the following set-aside billings and receipts for FY 87 by Department:

	Billed (Thousands)	**Received** (Thousands)
Department of Agriculture	not billed	$ 25.0
Department of Commerce	$ 13.0	12.1
Department of Defense	464.4	265.1
Department of Energy	not billed	218.0
Department of Health and Human Services	not billed	33.0
National Aeronautics and Space Administration	68.4	80.0
Total FY 1987 Funds Received		**$ 633.2**

Bills issued by NBS were based on NSF-reported intramural research and development expenditures. Some Departments, as shown, were not billed because their funds transfers were made before NBS issued formal bills. Thirty percent of the FY 87 set-aside funds were received in FY 88.

APPENDIX II

The Federal Laboratory Consortium - ORGANIZATIONAL ELEMENTS

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Subcommittee on Governments:

Chairman: Mr. R. Dedic

Subcommittee on Universities:

Chairman: Dr. J. Gumnick

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THE FEDERAL TECHNOLOGY TRANSFER ACT OF 1986: THE FIRST TWO YEARS

A REPORT TO THE PRESIDENT AND THE CONGRESS

BY

THE SECRETARY OF COMMERCE

JUNE, 1989

OFFICE OF COMMERCIAL AFFAIRS

TECHNOLOGY ADMINISTRATION

UNITED STATES DEPARTMENT OF COMMERCE

ROBERT A. MOSBACHER
SECRETARY OF COMMERCE

EXECUTIVE SUMMARY

The Federal Technology Transfer Act (FTTA) of 1986 (P.L. 99-502) was designed to provide a bridge between the superb research facilities of government-owned, government-operated (GOGO) laboratories and the research needs of the private sector. At the time it was pending in Congress, United States citizens were investing more than $50 billion annually in R&D. Many in Congress and the Executive branch believed that this investment, however vital for federal programs, was not returning to the taxpayers sufficient dividends in terms of new products, new processes, new jobs, and enhanced international competitiveness.

Reflecting the principle that those who best understand a technology and its economic potential are the ones who created it, the FTTA authorized agency heads to delegate to their GOGO directors the authority to enter into cooperative research and development agreements (CRADAs) with private firms and other appropriate parties, to agree in advance on rights the parties could expect in any inventions made by a federal scientist under the CRADA, to reward the inventor with at least 15% of any royalties received by the agency from the invention, and to review and clarify the missions of their laboratories.

In doing so, the FTTA required a change in prevailing agency practice and management prerogatives by transferring power from headquarters to the field. Some were concerned that the Act could interfere with agency management responsibilities, that it could divert attention from mission-related research, and that commercial considerations could discourage the free exchange of scientific information.

Under these circumstances the Department of Commerce, which plays a general oversight and coordinating role, was concerned that the Act would be interpreted in the narrowest possible manner. Instead, the Department found the following:

o Most agencies with substantial GOGO activity are relying on the FTTA and have completed the necessary internal administrative arrangements for implementing it. Although the delegations vary in scope, most have attempted to delegate authority to the smallest unit that can be realistically called a laboratory. The National Aeronautics and Space Administration is the one major research agency whose organic statutes, rather than the FTTA, guide their technology transfer policy. The Department of Commerce will continue to monitor the various agency arrangements to ensure that the principle of decentralization is preserved.

- As of the close of FY 1988, agencies had negotiated more than 100 CRADAs and the pace has accelerated in the current fiscal year. Several agencies believe that even though some of this research may have occurred under other authorities, the FTTA nevertheless provides a much more useful tool for structuring the collaborative arrangements.
- The FTTA has spurred agencies to think creatively in developing technology transfer initiatives. Examples include USDA's Peoria Biotechnology Consortium and the Army's Construction Productivity Advancement Research (CPAR) Program.
- The incentives to federal scientists appear to be working beyond expectations. Agencies have been generous in using their royalty-sharing authority, in some cases allowing inventors to retain as much as 35% of the royalty income. The number of reported inventions increased by more than 40 percent in some agencies between FY 1987 and FY 1988. Although CRADAs are too new to have generated royalties, the pattern of payments to inventors under the Bayh-Dole Act (P.L. 96-517, as amended), including the Department of Energy's government-owned, contractor-operated facilities, suggests that substantial royalties may be generated.

Nevertheless, there are still obstacles to be overcome:

- Barriers to commercialization of Federally developed software are still a problem. Software often has substantial commercial value which may not be realized because most U.S. firms will not make the investment necessary to bring it to the marketplace without adequate proprietary protection.
- Agencies repeatedly report that private sector collaborators worry that proprietary data will be made available to their competitors through FOIA. Such concerns may have deterred some firms from seeking to enter into CRADAs.
- The private sector does not always use federal facilities when they might. In order to facilitate identification of relevant areas of cooperation, agencies must continuously examine and define their laboratories' missions, as required by the FTTA, especially in those cases where the program justification is not clear. Foreign entities, on the other hand, are adept at identifying valuable research projects at federal facilities.

In general, agencies heads and laboratory personnel have greeted the Act with enthusiasm. U.S. firms are becoming increasingly aware of its relevance to their needs. The FTTA may well be creating the framework for a new era of scientific cooperation between the public and private sectors.

THE FEDERAL TECHNOLOGY TRANSFER ACT: THE FIRST TWO YEARS

1. Introduction and Overview:

Enactment of the Federal Technology Transfer Act (FTTA) of 1986 (P.L. 99-502) was largely a response to the increasingly tough international economic competition facing the United States. By all accounts, this competition will intensify as more countries, anxious to promote their economic development, enter the high technology competition. This is a healthy competition. The United States, however, will be unable to meet this challenge if it takes its technological leadership for granted.

Remaining competitive in fields such as superconductivity, biotechnology, new materials, pharmaceuticals, and other research-intensive areas could depend in large measure on our ability to link more closely our unsurpassed public research institutions with the needs of the private sector. U.S. industry's cooperation with universities and federal laboratories will become even more critical in determining whether we will be able to remain on the cutting edge of technology.

The Federal Government funds a substantial share of the R&D performed in this country - some 47%, according to the 1989 Economic Report of the President. Thus, a substantial share of the world's new scientific knowledge is paid for by the U.S. taxpayer. If this public investment is not translated into new jobs, products, and processes, we will have lost a significant opportunity for improving this nation's economic position.

The FTTA was enacted in response to these concerns. This law, along with former President Reagan's multi-phased program for improving access to federally funded research contained in Executive Order No. 12591, charged Federal agencies with linking their government-owned, government-operated (GOGO) laboratories to the private sector. This report summarizes how agencies have prepared to meet these challenges in the more than two years that have passed since the FTTA became law.

Most federal agencies have now completed, or are close to completing, the internal administrative arrangements necessary for managing programs of cooperative research with the private sector, universities, and state and local governments under the Act. Many have begun to negotiate agreements and a number of these have already been put into effect.

In general, agencies have made substantial progress and have developed firm foundations for successful technology transfer operations. By necessity, they concentrated first on resolving sensitive internal questions of control and accountability. Now they are addressing the practical problems of attracting the interest of the private sector and designing appealing arrangements.

To help them accomplish this and to ensure that Congress is kept fully informed on their progress, the FTTA required the Secretary of Commerce to (a) report to Congress every two years on how agencies are using their new authorities, (b) report to Congress on barriers to the commercialization of computer software and on the feasibility of maintaining an inventory of federally funded training software, and (c) provide agencies with model cooperative research and development agreements and other appropriate technical assistance.

Taking these in order, this report is the first of the biennial reports required by the FTTA. It is based on information provided to the Department by agencies represented on the Interagency Committee for Federal Technology Transfer, a forum established by former Secretary of Commerce Malcolm Baldrige to provide a continuing high level mechanism for addressing problems in implementing the Act and developing solutions. It is also based on follow-up questions and discussions within the Committee's Executive Working Group, a forum of senior headquarters and laboratory personnel which meets on a regular basis and which has become an important support network for addressing the practical problems agencies face in implementing the law and Executive order.

Major agencies providing information included the Departments of Agriculture (including the Forest Service and the Agricultural

Research Service), Commerce (including the National Institute of Standards and Technology, the National Oceanic and Atmospheric Administration, and the National Telecommunications and Information Administration), Defense (including the individual military departments), Energy, Health and Human Services (including the Public Health Service agencies), Interior, Transportation, and Veterans Affairs, as well as the Environmental Protection Agency and the National Aeronautics and Space Administration.

The report on barriers to commercialization of software and on federal training software was submitted in May, 1988. These barriers are discussed in this report in Section 9.a.

As to technical assistance, the Department has provided agencies with draft model agreements and continues to work with them on technical issues through the Interagency Committee and its Executive Working Group. This Group has met 13 times. In addition to the development of model agreements for working with industry, the Group has addressed model delegations of authorities for federal laboratories, employee conflict of interest issues, impact of the Freedom of Information Act, access by foreign companies and scientists to federal laboratories, protection of intellectual property in international science and technology agreements, problems in commercializing computer software, and training laboratory personnel in technology transfer.

But the real credit goes to the individual agencies. Their accomplishments have been particularly gratifying, given the many obstacles that had to be overcome before the FTTA could be successfully implemented. These obstacles must be understood if progress to date is to be evaluated properly.

First, the FTTA challenged the status quo. As a general observation, the FTTA forced many agencies to confront and reassess long-held attitudes with respect to:

- the role of federal laboratories and scientists in promoting joint R&D with industry and transferring the results to the marketplace,
- the necessary methods and incentives for accomplishing this, and
- the relationship between the laboratories and their parent organizations.

These various factors are discussed more fully in the pages that follow. Evidence has shown to date that most agencies are taking advantage of the opportunities the new law afforded them. Agency personnel at headquarters and in the laboratories are making sincere efforts to implement the new law as the President and Congress intended. Many practical problems have been resolved.

In short, federal technology transfer has gotten off to a good start and can look forward to a very promising future.

2. Technology Management Principles and the FTTA:

The fundamental objective of the FTTA is to promote U.S. competitiveness by allowing the private sector to pursue original R&D with our public research institutions, and by adapting the fruit of that research to the marketplace.

By 1986, Congress began to examine how the U.S. could reap substantial commercial returns on the $52 billion (now up to $63 billion) annual federal investment in research and development. A common complaint heard was that the U.S. wins Nobel Prizes while other countries walk off with the markets.

The designers of the FTTA responded by building upon certain fundamental principles.

o First, the federal government will continue to underwrite the cost of much important basic research in scientifically promising areas that takes place in the United States.

- Second, transferring this research from the laboratory to the marketplace is primarily the job of the private sector, with which the Federal Government should not compete.

- Third, the Federal Government can encourage the private sector to undertake this by judicious reliance on market-oriented incentives and protection of proprietary interests.

These principles were first tested by the Bayh-Dole Act (P.L. 96-517) upon which the Federal Technology Transfer Act was modeled. The Bayh-Dole Act generally allowed universities and small businesses to elect to own inventions made by them with federal funding and required universities to share royalties with the inventor. This was accomplished without diverting the universities from their primary educational missions.

That Act has been very successful in promoting university-industry cooperation. In its April 1987 report to Congress (GAO/RCED-87-44), the General Accounting Office found that such cooperation had increased 74% since passage of the Act.

Certain fundamental factors to the university successes quickly became evident:

- First, the translation of technology into commercial products usually requires the full cooperation and involvement of the people who created it and who best understand its potential. Research reports can never hope to convey all that the researchers have learned and absorbed. This is especially so in the case of federally-supported R&D where the resulting technologies tend to be far from commercialization. As such, supervision from "headquarters" must be such as to ensure proper accountability, but not so heavy as to discourage active involvement by laboratory personnel.

- Second, there must be early interaction between the creators of the technology and those who understand the complexities of manufacturing and marketing it. Technology developed in disregard of these practical considerations will often not benefit the public through practical application.

- Third, to bring this about there must be powerful incentives for all sides to cooperate. This is especially true for employees of public sector institutions such as our universities and federal laboratories where research is normally undertaken for broad public purposes.

The FTTA responded to these lessons. The new Act authorizes agency heads to delegate to laboratory directors the authority to enter into cooperative research and development agreements with the private sector and other entities, and to agree in advance on the rights the cooperating parties would have in any resulting inventions made by a federal employee. The employee was entitled to a guaranteed share of the royalties received by the government. The lab itself was also entitled to retain the majority share of the remaining royalties.

In addition, a mechanism was put in place designed not only to transfer federally-developed technology to the private sector but to make private sector scientific talent available to federal researchers as well, thus making the flow of information a two-way street and increasing the skills and expertise of all participants.

Thus, the key principles of decentralization of technology management, federal-private sector interaction, and suitable incentives were all satisfied in the new statute.

The Act did not specify exactly how it was to be implemented. Even the FTTA's most enthusiastic supporters knew that it would take time to change a culture that had existed for so long. President Reagan ended any lingering debate over how the law would be applied by issuing Executive Order 12591 on April 10, 1987. The President instructed the agencies to delegate authorities to their laboratory directors to implement the Federal Technology Transfer Act.

3. The Relationship of the Laboratory to its Parent: Decentralization of technology management is a central feature of the Federal Technology Transfer Act. Consistent with the principle that those who understand a developing technology best are those who created it, the Act encourages agency heads to make appropriate delegations to laboratory directors instead of retaining such authorities at headquarters, except as necessary to satisfy legitimate oversight needs.

In providing for a decentralized approach, the FTTA implicitly reflected a concern of the 1983 Report of the White House Science Council's Federal Laboratory Review Panel which had deplored the tendency of some agencies to micromanage their laboratories. The commission had emphasized that "excesssively detailed direction of laboratory R&D activities from agency headquarters...has seriously impaired R&D performance in some laboratories."

A review of agency rules implementing the Act reveals that agencies have displayed considerable sensitivity to the need to decentralize and to reduce the administrative burden on individual laboratories. All recognize that the point at which "the rubber meets the road" - where the heart of an agreement is developed - is the point at which contact between industry representatives and federal scientists occurs.

Most have made efforts to delegate authority to enter into agreements, subject to appropriate higher level review, to the smallest practical unit that can realistically be called a laboratory, which is defined in the Act as "a facility or group of facilities." But because of differences in agency missions, structures and traditions, different approaches have been taken toward decentralization.

For example, within the Department of Commerce, authority has been delegated to the Director of the National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards, for all arrangements within the scope of that organization's program responsibility. The Director has in turn delegated the authority to the directors of NIST's major laboratories: the National Engineering Laboratory, the National Measurement Laboratory, the Institute for Materials Science and Engineering, and the National Computer Systems Laboratory.

The National Oceanic and Atmospheric Administration, also at Commerce, has delegated authorities to five laboratories and three Assistant Administrators for research services.

The Department of Agriculture, on the other hand, has delegated authority to the Agricultural Research Service which, unlike NIST or NOAA, has chosen to treat itself as a single laboratory. To some degree, USDA's decision is rooted in practical considerations: it has 120 field locations, many of which are two- and three-scientist operations. USDA's approach is intended to ensure that these smaller operations receive encouragement and administrative support.

On the other hand, some of ARS's facilities have over 200 scientists. Accordingly, ARS and other organizations with similar arrangements must nurture decentralized technology management by the larger, more capable facilities while assisting their smaller, less capable components.

The Environmental Protection Agency has defined laboratories broadly so that it can apply to very small operations and even to those not normally considered to be laboratories in the layman's use of that term, such as its Policy Office. EPA's view is that even its Policy Staff develops computer models and that such models eventually may have commercial applications.

Given different agency needs and organizational charts, we cannot conclude that there is one "right" way. In future reports, the Commerce Department will address how particular delegation modes are working. Right now it is simply too soon to tell.

Although NASA is using the authorities of the FTTA as the basis for sharing royalties with its inventors, it has chosen to continue its centralized technology management system based on the authorities of the Space Act.

The Space Act, unlike the FTTA, (a) permits the agency to commit federal funds to cooperative ventures and (b) provides for greater centralization of authority, which NASA believes is more appropriate for its needs. NASA also has a long history of working with the private sector under this law. In future reports we will compare NASA's record with respect to the number of cooperative agreements with industry, royalties returned to the agency, number of inventions reported by its laboratories, and any other relevant factors, with the records of other agencies relying on the FTTA.

In the final analysis, however, the success of the FTTA depends less on the degree of freedom that laboratories have to enter into cooperative arrangements than it does on the respect which private firms have for the laboratories, their knowledge about laboratory capabilities, and their perception that these capabilities are consistent with their own needs.

It is here that the agency headquarters have a major role to play. The previously cited 1983 White House Science Council's report in reviewing agency-laboratory relations, complained that many laboratories had only ill-defined missions or obsolete missions and that "in most cases, the agencies' oversight means an excessive amount of reporting and paperwork, but inadequate scrutiny of the quality and relevance of the laboratories' activities." The Commission was concerned that a laboratory would confuse its mission with its preservation.

The FTTA recognized the importance of a clearly stated mission by (a) requiring each agency to make separate determinations of the mission or missions of each of its laboratories, and (b) making technology transfer a laboratory responsibility, to the extent consistent with its mission responsibility. Some of these facilities, such as those concerned with national security or national defense, have missions that are likely to result in only limited opportunities for pursuing private sector responsibilities. But for those whose missions are less clear, the degree or absence of private sector interest may be a useful indicator as to whether that facility's charter warrants reexamination.

The Department notes that the establishment of research advisory committees, such as those of USDA and NIST, could be important devices for agency use in ensuring that their R&D has practical applications.

4. Cooperative Agreements Under the Act:

The Department of Commerce estimated that, as of the close of FY 1988, federal agencies had concluded, or were in the final stages of negotiating, approximately 111 cooperative agreements within the meaning of the FTTA. Many of these are based on a model agreement which was developed by Commerce's Office of Federal Technology Management and modified by individual agencies to meet their specific needs.

These included agreements involving the Department of Agriculture (39), the Department of Health and Human Services (29), the Department of the Air Force (17), the Department of Commerce (10), the Department of the Army (7), the Department of the Interior (6), the Department of Veterans Affairs (2) and the Environmental Protection Agency (1). Agreements in fairly early stages of negotiation are not reflected in the above figures.

A number of points should be kept in mind in evaluating these figures.

First, the pace is clearly accelerating. NIH, a part of HHS, has informally advised us that it is now processing approximately 5 proposed R&D agreements each month. As such, the numbers for FY 1989 should be much higher. NIST, in the Department of Commmerce, has advised us that in the few months since the close of FY 1988, its agreements have almost tripled from the 10 noted above to 28.

Second, some agencies do enter into agreements similar to those described in the FTTA but rely on other authorities. NASA is a notable case. To the extent that they do so, the figures above are lower than they might otherwise be.

Third, some agencies perform much of their research through facilities other than GOGOs, such as DOE's contractor-operated facilities, and this research has commercial potential in areas ranging from solar energy to superconductivity. Such activities in support of technology transfer are not reflected in the above figures.

Fourth, agency use of the FTTA does not necessarily mean that the cooperation is "new" - i.e., that it would not have taken place in its absence. Many agencies have long and rich histories of cooperation with the private sector, state and local governments, and academic institutions. The Forest Service's record goes back to its establishment more than a century ago. NIST representatives have advised us that much of the research covered by its ten agreements might have occurred anyway, but that the FTTA is often a better vehicle for establishing these cooperative relationships.

Fifth, simply counting numbers misses the importance of vital new relationships formed under the Act such as USDA's Peoria, Illinois Biotechnology Consortium. This noteworthy project combines the resources of the USDA's Northern Regional Research

Center, the University of Illinois, six private companies contributing $1 million each, the State of Illinois (which is investing $4 million), and the city of Peoria. This type of highly promising cooperation fulfills the promise of the the Federal Technology Transfer Act and would be impossible without its sensitivity to the proprietary interests and motivations of the private sector.

Other notable examples of initiatives inspired by the FTTA include the following:

- In October 1988 HHS held its first NIH and ADAMHA-Industry Collaboration Forum which was attended by more than 250 representatives of leading pharmaceutical and biotechnology companies. The forum provided a means by which those representatives could meet directly with individual NIH and ADAMHA scientists to discuss potential cooperative research.

- The U.S. Army's Electronics Technology and Devices Laboratory developed a formal, comprehensive, well-focused procedure for implementing the Act which includes establishment of teams in specific technology areas, careful definition of objectives and responsibilities of each player, methods for developing statements of work for the research project, customization of model agreements and attendant legal reviews - all of which make it easier to obtain necessary approvals from higher authority. In short, ETDL appears to be striving to make the process routine while treating each agreement as a unique case.

- The Environmental Protection Agency has institutionalized the FTTA by forming an Office of Technology Transfer and Regulatory Support within its Office of Research and Development and has also established a Technology Transfer Advisory Committee to ensure that technology transfer issues are factored into program planning at its earliest stages.

- The Army's Corps of Engineers, by combining the intellectual property provisions of the FTTA with certain cost-sharing authority vested in it by the Water Resources Development Act of 1988 (P.L. 100-676), has developed a foundation for its new Construction Productivity Advancement Research (CPAR) Program. This initiative is designed to improve the applied research base that is available to the U.S. construction industry - an industry that has traditionally invested little in R&D.

- The Department of Energy has similarly combined FTTA-type concepts with other authorities as the basis of its Clean Coal Technology Project, a joint government-industry effort to demonstrate a new generation of environmentally clean, highly efficient coal technologies.

Some tentative conclusions regarding use of the law can be drawn.

First, many agency officials are of the view that the FTTA is more than "business as usual" and that a good number of the agreements represent research and cooperation that would not have otherwise taken place -- illustrated most dramatically in the Peoria Biotechnology Consortium. Representatives of the Army, Health and Human Services, and USDA's Agricultural Research Service were especially convinced of this. For future reports, the Department will closely watch for new relationships with the private sector that are forming because of the FTTA.

Second, officals of other agencies that believe the research would have taken place anyway note that the FTTA provides a better basis for undertaking it than was previously available to them.

Finally, most personnel believe that the Act has greatly stimulated agency personnel to think creatively in terms of technology transfer. That is discussed more fully in the next section.

5. Impact on Laboratory Personnel:

Federal scientists have traditionally had little reason to delay publication of their research, even though the disclosure of an invention in a printed publication before a patent application is filed destroys patentability in those countries that, unlike the United States, have no grace period that permits patenting within a specified period following publication. Most nations have no such provision.

As the White House Science Council reported more than five years ago - and as the Navy Department's experience confirms - many federal scientists rightly take great satisfaction from being able to advance scientific knowledge through publication of research results. Traditionally many federal scientists have viewed the private sector as an awkward partner with a different value system, and have published their findings even when this would prevent a patent from issuing.

The Federal Technology Transfer Act addressed this problem by creating important rewards for successful technology transfers for federal scientists and their laboratories. The FTTA directs agencies to pay the inventors at least 15% of any royalties their invention might bring in, and by allows the laboratories to share in the royalty stream as well. (Although the FTTA also permits agencies to develop alternative inventor incentive plans, all agencies have opted for the automatic royalty sharing plan.)

Thus, R&D funding under the FTTA has two vital goals: the traditional one of advancing scientific knowledge; and an important new element of seeking commercial applications for resulting discoveries.

A review of agency experience to date permits certain observations:

a. Increase in Number of Reported Inventions.

The widespread publication of information about the possibility of receiving royalties and the growing commitment of agencies to the principles of technology transfer appears to have contributed to the remarkable upsurge in the number of reported inventions by federal scientists during FY 1988, the first full fiscal year since enactment of the FTTA.

In FY 1987, the Department of Agriculture reported 76 inventions; in FY 1988 this figure had increased to 139. The Army reported 309 inventions in FY 1987; this figure was up by almost 40% in FY 1988 to 424. The Navy, where the tendency to publish had been particularly strong, saw its reported inventions increase by more than a third - from 336 in FY 1987 to 463 in FY 1988.

HHS figures, reported on a calendar basis, reveal that the number of inventions (133) reported during the first nine months of 1988 approximated the number (132) reported for all of CY 1987, a figure which itself represented an increase of almost a fourth over the number (109) reported in CY 1986.

This bodes very well for the impact of the Act. A similar jump in invention disclosures at the universities was the first sign of the impact of the Bayh-Dole Act. In 1976 there were about 230 patents issued to universities. By 1986 the number had tripled to about 700, increasing to 900 in 1987. Particularly striking is that this sharp increase in university patenting and invention reporting by federal scientists is occurring at a time when U.S. patent rates have levelled off or have declined for other sectors. Discussions with federal officials suggest that this increase in federal invention activity is likely to have real commercial significance, rather than leading to "paper" patents. This is an encouraging sign that U.S. creative activity is alive and well in our public sector and underscores the wisdom of President Lincoln's observation as to the importance of adding "the fuel of interest to the fires of genius."

Today, universities are becoming engines for economic development because of their successful technology transfers. High technology centers across the United States are forming around them.

Future reports will closely monitor whether the federal laboratories are following this heartening example.

b. Diversity of Plans:

The agencies have shown remarkable resourcefulness in devising royalty payment plans to suit their individual needs. Many recognize that inventions may bring in relatively modest dollar amounts and, to ensure some meaningful return, allow inventors to keep higher percentages of the first dollars that come back to the agency.

The military services, for example, will allow their inventors to keep 20% or the first $1000, whichever is greater. Within HHS, the National Institutes of Health, the Centers for Disease Control, and the Alcohol, Drug Abuse and Mental Health Administration allow their inventors to keep 25% of the first $50,000 in royalties, 20% of the next $50,000 and 15% of any additional royalties.

The Food and Drug Administration, also within HHS, takes the opposite approach. Greater percentages of the first dollars are retained by the agency. The FDA allows its inventors to keep 15% until program costs are recovered and 35% of any additional royalties. EPA allows its inventors to keep a flat 35% of all royalties.

Congress evidently recognized that agencies would take different approaches and encouraged experimentation. It directed the Comptroller General to report to it on the efficacy of different plans in 1991, thus giving agencies a chance to experiment and to alter their programs, if appropriate.

Accordingly, the Commerce Department will withhold further comment at this time except (a) to note that such differences do exist, (b) to express the hope that GAO's report will also discuss the experiences of agencies, such as NASA, which prefer to rely on authorities other than the FTTA, and (c) to assure the Congress that the Commerce Department will also monitor these various plans.

c. Royalties to Date:

Although interest is high and implementation plans are in effect, the agreements under the FTTA are too new to have generated any significant royalty income.

However, data from the Department of Energy and the National Technical Information Service provide some useful insights.

In 1980 Congress enacted legislation which, as discussed earlier, allowed certain federal contractors to own and license inventions made with federal funding. This law applied to many of DOE's contractor-operated facilities. The remaining DOE contractor-operated facilities received ownership on a case-by-case basis under other authority. All of these facilities, however, established royalty sharing programs with their employed inventors.

In 1981, DOE's contractor-operated laboratories received $14,000 in royalties. In FY 1985, these royalties had increased to $144,000 and in FY 1987 they stood at $297,000. For FY 1988 the figure reached $584,000.

Preliminary data from the National Technical Information Service (NTIS) suggest the same trend is beginning for federally-owned and -operated laboratories. NTIS, even prior to enactment of the FTTA, licensed federally owned patents for royalties or other consideration under the provisions of Section 207 of Title 35. It also paid inventors a share of resulting royalties, but its authority to do so was uncertain. The FTTA made it clear that inventors were entitled to a share of royalties under either a cooperative R&D agreement or the Government's "207" program.

For FY 1985, NTIS collected $1.5 million in royalties in connection with 146 federally owned inventions and paid out approximately $69,000 to inventors. For FY 1988, by which time federal scientists became more aware of the possibility that they could profit from their inventions and legal confusion had been resolved, royalty payments had increased almost fourfold to

$5.6 million, the number of inventions increased by almost 40% to 201, and awards to inventors amounted to $356,200.

These results have been achieved in a manner consistent with the objective of preserving the free flow of information. As noted earlier, we have already seen a dramatic increase in the number of reported inventions at universities without any corresponding decrease in the number of scholarly publications. At most, there has been short-term publication delay to afford the laboratory an opportunity to decide if a patent should be sought. Indeed, universities are generally seeing an increase in both patenting and publishing rates, including a striking increase in co-authored university-industry publications in the decade following enactment of Bayh-Dole.

In short, if the experience of the universities and NTIS is any guide, a fair program of royalty sharing, when coupled with support and encouragement by laboratory managers and the parent agencies, should yield steady progress.

6. International Considerations:

The ultimate aim of all federal technology transfer initiatives is, as indicated in Section 2, to promote the ability of U.S. firms to compete in world markets. U.S. taxpayers contribute more than $63 billion each year to federal R&D initiatives. To the extent that this investment can yield new products, new processes, new industries and new jobs, those taxpayers ought to be the principal beneficiaries.

In the Bayh-Dole Act, Congress prohibited not-for-profit contractors electing to take title to federally financed inventions from giving exclusive licenses to firms that did not agree to manufacture the invention in this country - except to the extent that domestic manufacture was impractical or efforts to find licensees that would agree to such terms proved unsuccessful.

During the 1980's, as concern about U.S. competitiveness began to mount, this emphasis on domestic manufacture as a means of protecting the taxpayers' investment was seen as insufficient. Focus shifted from the relatively narrow issue of where a particular invention might be used or manufactured to the broader question of whether the taxpayer-financed technology on which the products of tomorrow might be based was being given away without receiving an adequate quid pro quo, particularly as other nations demonstrated an adroitness at turning basic research into products for the marketplace.

It has long been evident that our foreign competitors routinely scour our public R&D institutions looking for technology leads. Historically the United States has been by far the leader in conducting - but not necessarily commercializing - basic research. Countries such as Japan are redoubling their efforts to close the basic research gap.

Thus, the drafters of the Federal Technology Transfer Act were concerned that the advantages of entering into cooperative research arrangements with federal laboratories not be extended to participants from foreign countries that deny U.S. entities the right to enter into similar ventures. The Act required laboratory directors to consider such practices when deciding which proposals to pursue.

Since then there have been a number of other instances in which Congress and the Executive branch have expressed their determination that the United States receive an appropriate quid pro quo before making its technology available to foreign entities whose governments fail to protect our interests or discriminate against us.

In Executive Order No. 12591, President Reagan expanded upon that principle by requiring laboratory directors to consider also the extent to which the relevant foreign government protects intellectual property. Subsequently, in the Omnibus Trade and Competitiveness Act of 1988, Congress required that federally supported international science and technology agreements be negotiated so as to ensure: 1. that the United States enjoys similar access to the research facilities of the other countries as we grant here (i.e., the agreement should ensure "symmetrical access"); and

2. that the other country provides proper protection for intellectual property. It also required that proposed science and technology agreements be reviewed for their consistency with the principles of the Bayh-Dole Act and the Federal Technology Transfer Act.

In short, the requirements of the FTTA should not be viewed in isolation but as part of broader, evolving policies aimed at encouraging agencies to exercise greater discretion with respect to, and control over, commercially valuable, federally financed technology.

In consultation with the various agencies, an informal system has been devised whereby laboratories will simply notify the Department of Commerce when they have identified a party proposing an agreement as being foreign controlled and the Department will consult with the United States Trade Representative. The laboratories then will be advised as to whether the home country's protection of intellectual property is adequate and whether there is any evidence that it denies U.S. firms the right to enter into similar agreements or otherwise precludes their access to its research facilities.

It should be noted, however, that Congress has not provided agencies with much guidance for determining what is meant by "foreign controlled." However, Congress recently defined the concept in the "Buy American Act of 1988" (see Title VII of P.L. 100-418) and the Department and USTR are considering the extent to which these standards can be adapted for use by agencies in implementing the FTTA.

The Department of Commerce published a request in the Federal Register in April 1988 for information from the public concerning denial of access to foreign research facilities. It followed up with press releases, letters to private firms and calls to trade associations to urge them to bring the request to the attention of their members. To date, the Department has received some information as to potential problems but no specific, identifiable cases of governmentally-imposed barriers to U.S. participation in foreign R&D programs.

This response is not surprising given that the concept of conducting R&D with foreign research institutions is generally new to American industry. U.S. firms, until recently, have shown only limited interest in working with federal facilities, much less with those operated by foreign governments. Many domestic companies are skeptical as to whether invitations from foreign entities to enter into such agreements are made in good faith or are attempts to tap into our existing technology base. These views may change with the increased internationalization of science and technology.

The Department of Commerce will continue to monitor this situation so that it can advise federal laboratory directors when barriers are encountered in specific countries. It is currently participating in an interagency task force chaired by the National Science Foundation which is aimed at developing concepts for measuring the symmetricality of access in the context of the recently-concluded U.S.-Japan Science and Technology Agreement. The Committee's work should be useful in reviewing U.S. access in other situations.

Congress' concern that agencies be sensitive to these various international considerations is not surprising. Foreign nations have been remarkably adept at identifying the sources of valuable technology in the United States that will lead to new products. The extent of foreign participation in federal laboratory research was recently documented in an August 1988 report by the General Accounting Office entitled "U.S. and Foreign Participation in R&D at Federal Laboratories" (GAO/RCED-88-203BR).

It would be ironic if these foreign firms prove themselves to be more farsighted in identifying opportunities for cooperation with federal facilities - and in reaping the attendant technological advantages - than our own domestic companies. As GAO's Report found, given staffing and space constraints that limit the number of outside researchers who can conduct R&D at federal laboratories, "the best way to control foreign participation is to stimulate U.S. participation." (Id., p. 52).

Accordingly, even though the relative newness of the FTTA and the small number of agreements entered into thus far permit no conclusions to be drawn, it will be necessary to monitor the relative degree of foreign versus domestic interest in entering into collaborative arrangements under the FTTA.

7. Statutory and Other Problems:

a. Computer Software.

Because copyright law prohibits federal employees from obtaining copyright protection for works created in the course of their official duties, the incentives of proprietary protection and royalty sharing - so vital in the case of inventions - are unavailable to spur the development of computer software that for legal or practical reasons cannot be patented. Such software can have substantial commercial value.

DOE's GOCOs are not subject to this prohibition and their experience reveals just how important proprietary rights can be as a spur to the commercialization of software developed in connection with federal programs. A good example is DOE's encouragement of an Oak Ridge National Laboratory consortium. This consortium is a cooperative agreement between twelve sponsoring companies who are co-funding the development of user friendly and intelligent software systems for more easily accessing a highly complex set of finite element analysis models.

GOGO research should yield equally satisfying results. The Department of Defense, for example, expends considerable effort in developing computer-based vocational training materials which may have significant commercial value for a wide range of vocations and disciplines.

The Agriculture Department noted that virtually none of the cooperative agreements signed or under negotiation dealt with expert systems, artificial intelligence or other forms of knowledge engineering, even though the systems approach and software-derived technology reflected a growing portion of its research. Indeed, USDA also noted that this problem antedated the FTTA and that the government's inability to provide software protection had been a major factor in its inability to interest the private sector in its activities in such fields as crop production, forage-livestock interaction, and food processing-quality interaction.

It thus appears that the absence of an ability to convey proprietary rights might result in the loss of significant opportunities for federal-private sector cooperation in areas of significant commercial potential.

Merely making software available without proprietary protection, may be insufficient to ensure its effective commercialization. Much of today's software is complex, containing thousands of lines of code. It is often useless to businesses unless they are willing to make substantial investments of time and money. For software to be commercially valuable, it has to be debugged, simplified and customized and training manuals must be available as well. Without an appropriate license, a firm could not be assured of recouping the necessary investment in providing such services.

Simply stated, the plain fact is that without an appropriate policy dealing with the commercialization of federally-developed software, the prospects for its development and commercialization will probably be limited.

The drafters of the FTTA were certainly aware of this. The legislation specifically required the Commerce Department to study the issue and make appropriate recommendations. In May 1988 then Secretary of Commerce C. William Verity submitted the required report recommending corrective legislation; at about the same time, the General Accounting Office issued a report to Congress (GAO/RCED-88-116BR) which also noted that the absence of copyright protection for computer software was perceived by laboratory and agency officials as a technology transfer constraint.

The Department of Commerce, in consultation with other agencies, is developing suggestions for legislation that could be reviewed by the Administration. The Department and agencies will also consider the question of whether a similar limitation on the ability of federal scientists to obtain protection for semiconductor chip mask works should also be lifted. Such works are not protected by copyright but, rather, receive a sui generis form of protection under Title 17. Nevertheless, the same limitation applies.

b. Freedom of Information Act:

One major incentive for the establishment of cooperative relations between a private firm and the government is the existence of an expensive or unique research facility where federal scientists and scientists employed by a firm can work "shoulder to shoulder" on proprietary research. But, as GAO's March 1988 report found, the opportunities for this are limited at least in part by the government's inability to assure the firm that the results will not be made public to its foreign or domestic competitors under the Freedom of Information Act (FOIA).

The experience of the federal laboratories since that report was issued confirms GAO's earlier finding. Many agencies reported that protection of proprietary information was one of the first issues raised by potential R&D partners. The frequency and regularity with which the issue is raised to laboratories by the private sector suggests that such concerns may have deterred many firms from seeking cooperative arrangements with federal institutions in the first place.

Accordingly, the Department will continue to work with agencies to determine the extent to which FOIA may impede the negotiation of advantageous cooperative research and development agreements. Laboratory officials have informally advised the Department that they believe that the objectives of FOIA, the goal of preserving open scientific communication, and the proprietary interests of sponsoring partners can be balanced by offering the sponsoring partner a limited period of exclusivity after which the information would be subject to disclosure under FOIA.

c. Personnel Matters.

Personnel in federal laboratories often do not have the knowledge and skills essential for effectively negotiating complex agreements with the private sector. This limitation could undermine the FTTA's basic objective of encouraging the laboratories themselves to take an active role in promoting the transfer of federally funded technology.

Accordingly, it would be helpful to consider methods that could be used to improve the skills of technology managers and scientists in negotiating agreements with the private sector.

Several agencies also have indicated that they may be unable to hire enough patent attorneys to support their technology transfer programs. These agencies note that patent lawyers command far higher compensation in the private sector than federal agencies can hope to offer. Contracting for such services may be an available alternative. Patent counsel are essential to the process of determining patentability, drafting technical documents, and negotiating advantageous licensing arrangements. The FTTA does authorize agencies to use royalties to pay for such services. Perhaps as royalties increase this problem may be somewhat eased.

At the present time, the Department of Commerce does not believe it has sufficient data to justify any specific recommendations. However, these personnel matters warrant careful monitoring. We expect to return to it in the next biennial report.

c. Conflicts of Interest:

In September 1988 the U.S. Office of Government Ethics (OGE) advised the Department of Commerce that royalty sharing under the FTTA is "a form of compensation from the Government which does not cause an employee to have a personal financial interest to which the conflict of interest laws are applicable." OGE noted that under the statutory scheme, a federal employee is not placed into a direct relationship with the party paying royalty fees.

However, agency employees remain bound by the statutory provision (18 USC 207) that bars a former federal employee from representing another person before an agency on matters that the ex-employee worked on while at the agency. Any matter in connection with the invention in question would appear to bring that section into play.

In addition, some agencies, while aware of OGE's opinion, believe that their particular mission may obligate them to impose special rules. The Food and Drug Administration, for example, has expressed concern about potential conflicts that could arise when its scientists stand to profit from inventions that cannot be marketed without that agency's express approval. FDA is in the process of reviewing its regulations to ensure that its concerns are addressed without unduly limiting the ability of its personnel to take advantage of the opportunities accorded them by the FTTA.

The Commerce Department expects shortly to issue FTTA conflict of interest guidelines to assist agencies in this area and will be pleased to work with them individually, if requested.

8. Conclusion:

In summary, progress to date under the FTTA has been good.

- Agency administrative personnel understand the Act's merits and are anxious to make it even more effective.

- Laboratory personnel are becoming more and more interested in making their work useful to the private sector.

- U.S. firms are becoming increasingly aware of the Act and in many cases are finding out that the federal laboratories are conducting research that can valuable to them.

There is still work to be done, but the Act's goal of fostering a new era of scientific and technical cooperation between the public and private sectors appears well on the way to becoming a reality.

ADDITIONAL QUESTIONS FOR BRIGADIER GENERAL JOHN DOUGLASS AND RESPONSES

HOUSE COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY			INSERT FOR THE RECORD					
☐ ☐	HOUSE SENATE	APPROPRIATIONS COMMITTEE	☐ ☐	HOUSE SENATE	ARMED SERVICES COMMITTEE	☐ ☐	HOUSE SENATE	OTHER
HEARING DATE 1 JUN 1989		TRANSCRIPT PAGE NO. QFR	LINE NO.		INSERT NO. 001 thru 006			

Question: At the present time, what review of laboratory-negotiated cooperative research and development agreements is required at the Air Force headquarters level?

Answer: There is no requirement for laboratory-negotiated Cooperative Research and Development Agreements (CRDAs) to be reviewed at the Air Force headquarters level.

The draft Air Force Regulation on Domestic Technology Transfer stipulates that the laboratory Commander shall enter into a CRDA, and that the official to whom he or she reports, or his or her designee shall review all negotiated Cooperative Research and Development Agreements (CRDAs).

Laboratory-negotiated CRDAs are reviewed by the Science and Technology Directorate of the Air Force Systems Command, the major command to whom all laboratories report. The reviewing official has authority to approve, disapprove, or require modification of any CRDA, each of which shall provide a 30-day period within which such action must be taken beginning on the date the agreement is received by the reviewing official.

Question: Is the requirement that adverse action on any such negotiations be handled within 30 days from date of receipt by your department being complied with?

Answer: Yes. Also, there has been no adverse actions.

Question: What regulations and instructions still must be promulgated by your service to fully implement the cooperative R&D authority? What is the timetable?

Answer: To fully implement the cooperative R&D authority, an Air Force regulation (AFR) must be promulgated. AFR 80-XX, Domestic Technology Transfer, which will establish Air Force policy, delegation of authority, and procedures for domestic unclassified technology transfer by Air Force organizations has been extensively coordinated throughout the Air Force, especially within the legal community, and is currently in the publishing division for editing and typesetting.

AFR 80-XX delineates procedures for entering into CRDAs with non-federal parties, commercialization of Air Force technology, licensing of inventions, and the distribution of royalty income resulting therefrom. It also defines the responsibilities of Offices of Research and Technology Application. A model CRDA is attached to the proposed regulation to provide guidelines for negotiating and entering into CRDAs, and which may be tailored for each negotiation.

It is anticipated that AFR 80-XX will be promulgated before the end of the year.

Question: In the next year or so, what level of growth do you expect in the number of cooperative R&D agreements negotiated by Department of the Air Force laboratories?

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☐	HOUSE	APPROPRIATIONS COMMITTEE	☐	HOUSE	ARMED SERVICES COMMITTEE	☐	HOUSE	OTHER
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HEARING DATE	TRANSCRIPT PAGE NO.	LINE NO.	INSERT NO.					

Answer: To date, twenty-four Air Force CRDAs have been or are currently being negotiated. These CRDAs have been negotiated with state and local Governments, academia, and private industry. Our progress in entering into CRDAs will accelerate as we become more familiar and comfortable with the legislation. We anticipate a 30% increase in the number of CRDAs in the next year.

Question: With regard to Section 11(a)(3), how has your Service insured that technology transfer is being considered positively in laboratory job descriptions, employee promotion policies and evaluation of job performance of scientists and engineers in your laboratories?

Answer: The draft Air Force regulation stipulates that each Air Force research, development, test and evaluation (RDT&E) activity is required to incorporate technology transfer objectives into the mission of its activity, and shall encourage that efforts to transfer technology be recognized in evaluation of the job performance of scientists and engineers.

A policy statement from the Office of the Secretary of the Air Force will be promulgated to all laboratories stipulating that technology transfer efforts must be considered positively in laboratory job descriptions, employee promotion policies, and evaluation of scientists and engineers in the laboratory. We anticipate this letter of policy will be promulgated before the end of the year.

Question: Have your laboratories established Offices of Research and Technology Applications (ORTA's) and staffed them as required by law?

Answer: The Air Force has established ORTAs at each laboratory as specified in the legislation. In addition, there is a domestic technology transfer functional office established within the Office of the Assistant Secretary of the Air Force Acquisition. This office makes reports to Congress, and promulgates regulations and operating procedures.

Question: Are there any legislative changes to the law which you believe would be desirable?

Answer: Although the Air Force has no specific legislative changes to propose, there are two areas in which we will be paying careful consideration and attention - namely, copyright and the Freedom of Information Act (FOIA).

Works of Government employees are not subject to copyright protection because they are in the public domain. Software developed by a Government employee, therefore, is currently distributed on a no fee basis. There is not an incentive/reward system for the computer scientist/programmer to "market" software, in contrast to the patent licensing system that provides an incentive and reward for the inventor.

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HEARING DATE	TRANSCRIPT PAGE NO.	LINE NO.	INSERT NO.					

We have not identified any impacts of FOIA on companies who might enter into CRDAs. We would protect company information from release to the same extent whether that information came to us through cooperative research or other submittals. The federal procurement laws should have no effect on CRDA participants. By statutory definition, a CRDA is not a procurement contract, so these laws should not be applied by an agency.